Gender, Religion, and Ethnicity:

A sociocultural perspective on child nutritional status in Indonesia

Yohanes Sondang Kunto

Propositions

1. Empowered mothers influence the nutritional status of their sons and daughters either positively or negatively.
   (this thesis)

2. Food culture enriches the interdisciplinary study of nutrition and offers additional insights to policymakers.
   (this thesis)

3. Quantitative analyses average out the outliers, hindering our chances to learn from those positive or negative deviants.

4. It requires the often overlooked social marketing to sell positive behaviours, including that of a healthy lifestyle.

5. The pandemic alone does not kill people, but denial and ignorance do.

6. Coffee is one reason the world we live in today progresses and flourishes.

Propositions belonging to the thesis, entitled

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To my beloved daughter Rivkah Sere br. Rajagukguk†

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Introduction

1.1 Problem Definition

Malnutrition, which is defined by the World Health Organization (WHO) as the "deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients" (Haddad 1999), has long been recognised as a decisive factor that could potentially hold back individual and societal advancement (Berg & Muscat 1973; Hakim & Solimano 1976). Those who were malnourished in childhood may experience ill-health (Bargain & Zeidan 2016), low social capability (e.g., low self-efficacy, low self-esteem, passive aspiration) (Sánchez 2017; Sohn 2016), and compromised cognitive capacity later in life (Almond et al. 2014; Sánchez 2017). These consequences of malnutrition may not only reduce individual well-being, but at macro level, could increase the national health expenditure (Aizawa & Helbe 2018) and may lower the labour productivity (Schultz-Nielsen et al. 2016; Majid 2015)

Previous studies have shown that the sociocultural and economic context a person lives in may influence his or her nutritional status and that of their significant others. For instance, adults who are poor are less able to provide food security for their families (Deaton & Paxson 1998; Deaton 2003). They might also have to struggle with access to clean water and quality health services (Deaton 2003; Cunningham et al. 2018). These conditions expose not only themselves but also their children to low-quality dietary intake and a more intense disease environment, the two immediate causes of malnutrition (UNICEF 2015; UNICEF 1991).

Unlike the often-straightforward pathways that link economic factors and nutrition, sociocultural factors operate more "invisibly" by influencing people's beliefs, attitudes, and behaviour toward food and other health inputs (den Hartog et al. 2006; Niehof 2019). Among these sociocultural factors are gender, religion, and ethnicity (Madjdian et al. 2018). On gender, for example, previous studies have shown that South Asian girls of under-five (years of age) are more likely to be malnourished than boys in that category (Bose 2011; Dasgupta 2016; Das Gupta 1987; Jayachandran & Pande 2017). Many have suggested that perhaps the son preference for which most South Asian patrilineal-patrilocal societies are well-known, plays a role in the often different nutritional status experienced by gender (Dasgupta 2016; Das Gupta 1997; Jayachandran & Pande 2017). In such societies, the subordinate position that young girls and women have relative to men has been thought to reduce female access to nutrient-rich foods, e.g., animal-source foods and dairy products, which consequently rendered them to be malnourished (Madjdian & Bras 2016; Gittelsohn et al. 1997; Gittelsohn 1991; Madjdian 2018). Although this pathway of gender bias in food allocation may well explain the cause of malnourished under-five South Asian girls, the same pathway seemed to be a mismatch once boys and girls had grown into adolescence. In their report, WHO (2006a) suggested that for certain regions in South Asia and the neighbouring Southeast Asia, more adolescent boys were malnourished than girls: an evidence that contests the previous hypothesis of gender bias against girls in food allocation.

Identifying and interpreting the pathways of how religion and ethnicity may affect nutritional status are no less challenging than that of gender. Omigbodun et al. (2010) for example, found that based on stature, Muslim and Christian adolescents in Nigeria were different in their nutritional status. Omigbodun et al. (2010) proposed that cultural practices specific to a certain religious group might cause the difference. However, like many other studies on the topic, e.g., Assefa et al. (2015) and Khongsdier & Mukherjee (2003), Omigbodun et al. (2010) did not sufficiently describe what these cultural practices were and how they could influence nutritional status. The same limitation is also often found in studies reporting ethnic group differences in nutritional status, e.g., Panter-Brick et al. (1996) and Benefice et al. (2006).

The emergence of malnourished adolescent boys in certain South Asian and Southeast Asian regions, and the ambivalent pathways through which religion and ethnicity may impact nutritional status in childhood (0–9 years of age) and adolescence (10–19 years of age), calls for further research. Moreover, while many studies have shown that empowered mothers could improve the nutritional status of their young children and could lessen the probable gender gaps in early childhood (0–5 years of age) (Bose 2011; Khatun et al. 2004; Burroway 2016), research on the role of women's empowerment in influencing adolescent nutritional status is rare. Thus, the relation between women's empowerment, gender inequality, and nutrition in adolescence is a further research gap requiring investigation.

Indonesia is a very interesting case to study how sociocultural factors may influence nutritional status in childhood and adolescence. It is the world's fourth largest country in terms of population, a home to more than 250 million people with 1,300 ethnic backgrounds (Hugo 2015; Statistics Indonesia 2011; Ananta et al. 2015). The nation is the world's largest country of Muslim majority. At least 87.18% Indonesians are Muslims, while the rest are Protestant (6.96%), Catholic (2.91%), Hindus (1.68%), Buddhist (0.72%), and others (0.55%) (Statistics Indonesia 2011). Although the gender norms are generally egalitarian, the adopted kinship systems and the accompanying gender relations vary widely between ethnic groups (Guilmoto 2015; Hugo 2015). The Javanese, the largest ethnic group in Indonesia (40.06%), has a bilateral kinship system. Other ethnic groups such as the Batak (3.58%) are patrilineal-patrilocal, while the Minangkabau (2.73%) is traditionally matrilineal (Statistics Indonesia 2011; Ananta et al. 2015). Despite being an emerging middle-income country, the prevalence of malnutrition remains high in Indonesia. More than 37% of all under-five children and 31% of all adolescents between 16 and 18 years of age were stunted or too short for their age (MoH 2013). In adolescence, Indonesian boys are often worse off than girls in nutritional status. This was revealed by a much higher percentage of boys who were stunted than girls at 18-years of age (37.4% vs 26.2%) (MoH 2013). Overweight has also become an important issue in Indonesia recently. While only 1.4% of all under-five children were overweight or obese in 2010, this proportion has increased at an alarming rate to 16.7% in 2016 (NCD-RisC 2017; Statistics Indonesia 2013). This fact suggests that Indonesia is now facing a double burden of malnutrition, a condition where undernutrition and overnutrition co-exist in the same population. With such intense contextual differences and change, research on malnutrition in childhood and adolescence in Indonesia should not only enrich the current interdisciplinary studies of nutrition, but have significant societal relevance as well.

1.2 Theoretical Framework

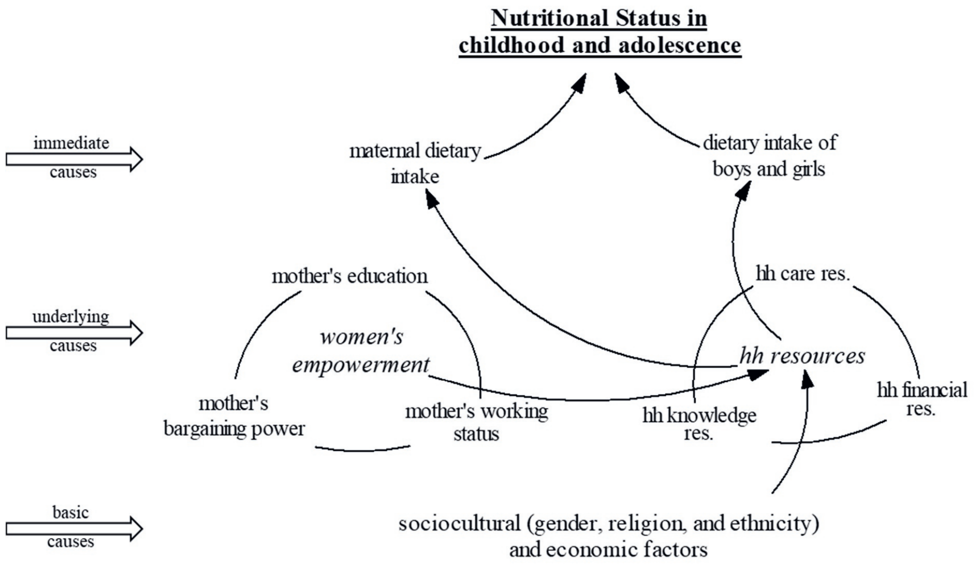
In studying the process and determinants of nutrition outcomes, this thesis departs from the pivotal UNICEF conceptual framework on the causes of malnutrition (UNICEF 2015; UNICEF 1991). That framework has inspired not only researchers, but also policymakers in their efforts to understand the causes and consequences of malnutrition and the effective ways to overcome such condition of ill-health.

The UNICEF conceptual framework maps the causes of malnutrition into three hierarchical levels of determinants (Smith & Haddad 2000; Haddad 1999; Smith & Haddad 2015). First are the immediate causes. These include dietary intake and diseases. Both factors operate at the individual level, work interdependently, and directly affect nutritional status. At this level, those who consume a low-quality diet that is either inadequate in quantity or poor in nutrients are more vulnerable to diseases. These diseases may suppress appetite for food and thereby limit the nutrient absorption required to live and grow healthily.

Second are the underlying causes. The underlying causes are manifested at the household level and affect nutritional status through the aforementioned immediate causes. These determinants consist of household food security, maternal and child-care, and healthy living environments. Without food security, there is no assurance that each household member may receive their fair share of food and nutrients to sustain a healthy life. Regarding maternal and child-care, support for pregnant and lactating mothers such as adequate food consumption, enough rest, and safe-guarding mothers' mental health (e.g. protection from abuse) are necessary for women to function well, particularly in their traditional role as the primary caretakers (Smith & Haddad 2015). Feeding practices, e.g., food provision and supervision, and health-seeking behaviour are no less important. These practices are to ensure optimal growth and nutritional well-being of boys and girls. The healthy living environment factor includes clean water, hygiene and sanitation. All are necessary to prevent household members from being exposed to pathogens.

Third are the basic causes. This is where socio-cultural, the focuses of this thesis, and economic factors come in. Both are societal-level factors, which affect nutritional status through a long chain of underlying causes and immediate causes. Theoretically, good governance and economic growth should elevate people from poverty and improve overall food security, maternal and child-care, and healthy living environments (Ruel & Alderman 2013). However, good governance and economic growth alone cannot ensure that everyone shall receive equal benefits in terms of nutritional status. The sociocultural factors, e.g., gender, religion, and ethnicity, may vary allocation of food and non-food resources within and across households and thereby produce inequality in nutritional status (Madjdian et al. 2018).

This thesis derives its theoretical framework from the aforementioned UNICEF conceptual framework. In contrast to that framework however, a greater focus is given to exploring how women's empowerment at the household level and dietary intake may affect nutritional status in childhood and adolescence (0–19 years of age). This thesis sums up the underlying causes determined by the UNICEF conceptual framework into household resources in terms of knowledge, financial resources, and care. It also links three indicators of women's empowerment as contributing factors to household resources, namely mother's education, mother's working status, and mother's bargaining power (Phan 2016). Furthermore, instead of placing gender at every level of nutrition determinants, similar to Haddad's (1999) gendered version of the UNICEF framework, this thesis understands gender as the part of norms and values which are embedded in basic causes of child nutritional status. Along with religion and ethnicity, gender may then affect how different households use and distribute their resources, particularly in relation to dietary intake of mothers and their children. Figure 1.1 shows the theoretical framework of this thesis. In the two subsections below, this thesis further explains the hypothetical pathways of how gender, religion, and ethnicity may influence nutritional status in childhood and adolescence.



Adapted from the 1990 UNICEF conceptual framework on the causes of malnutrition (UNICEF 2015; UNICEF 1991). Women's empowerment indicators are from Phan (2016). hh = household; res. = resources.
Source: Author

Figure 1.1. Pathways, causes, and associations of children's nutritional status

1.2.1 The influences of gender and women's empowerment on nutrition

Gender norms drive people's beliefs and attitudes on how they are expected to act and behave towards men and women in daily routines, and can also apply to the allocation of food and nutrition (Niehof 2019). In relation to nutritional status of boys and girls, South Asia is an excellent example to illustrate such gender application. The region has a strong patrilineal kinship system and strong norms of son preference. India is an extreme case in (eldest) son preference norms. The country's vital statistics show excess mortality rates for under-five girls (Callister 2018; Guilmoto et al. 2018), the so-called "missing daughter" phenomenon (Das Gupta 1997). The explanation for this phenomenon has been sought in sex-selective abortions and in girls and women receiving less shares of food and medical care than males (The Guardians 2018). Gender inequality in intra-household food allocation had also been found for Nepal. Most Nepali daughters and young women, particularly those who live in Hindu communities, have to eat last and often must content themselves with the leftover foods (Madjdian & Bras 2016; Gittelsohn et al. 1997; Gittelsohn 1991). Such gender biases jeopardize female nutritional status.

In societies with high gender inequality, women frequently have a lower status than men (Bose 2011; Das Gupta 1987; Jayachandran & Pande 2017). This subordinate position of women limits the mother's space inside and outside the household. The condition may not only restrict her chances to venture outside the household for work and thereby contribute to the household economy, but also reduce her agency within the household. Most likely her voice would be valued less and her bargaining power become weaker, particularly when it comes to advocating usage of household resources for her children's needs (Richards et al. 2013; Thomas et al. 2002).

Women's empowerment is intended to improve the situation. It leverages women's status by restoring and expanding what is supposed to be her authority, capacity, and agency to decide what is best for her life and the lives of her significant others (Cunningham et al. 2015; Kabeer 1999; Malhotra et al. 2005). This is the core meaning of women's empowerment. Based on data from Southeast Asia, Phan (2016) proposed three indicators of women's empowerment: mother's education, mother's working status, and mother's bargaining power. Figure 1.1 presents the three interlinked women's empowerment indicators and their relationship with household resources, dietary intake, and nutritional status in childhood and adolescence.

How do these three indicators of women's empowerment work to elevate boys and girls from malnutrition and to promote gender equality in nutritional status? Previous studies of under-five children have quoted two mechanisms. First, mother's education was thought to indirectly improve mother's access to information which ideally would enrich the household's knowledge on sound health care and practices (Burroway 2016). Educated mothers may also benefit their children through effective use of health care services and openness to new diets and nutrition interventions (Smith et al. 2003). Second, formal education is related to mother's chances to enter the labour market and to find (better-)paid jobs. This second mechanism immediately links the other two indicators of women's empowerment: the mother's working status and mother's bargaining power.

Earnings that the mother receives from work gives her economic independency and increases her contribution to the household financial resources. Hence, work increases women's control over household financial resources, which allows her to raise her voice in intra-household bargaining around these resources (Sen 2009). However, it may also come with negative consequences, specifically in relation to the amount of time she can devote to care. Work might leave the mother with less time to spend with her children and may lower her capacity to supervise her children's diet and physical activities (Cunningham et al. 2015; Engle et al. 1999). Previous studies have argued that the mother's voice in intra-household bargaining is positively correlated with pro-child resource flows regarding dietary intake and health inputs (Richards et al. 2013; Thomas et al. 2002; Rashed et al. 1999).

Empowered mothers may also promote gender equality in nutritional status and compensate for apparent inequalities (Bose 2011; Skoufias 1999; Khatun et al. 2004). This has been shown in the patrilineal-patrilocal context of South Asia where mothers improved the diet of the disadvantaged young girls (Bose 2011; Khatun et al. 2004). In Bangladesh, the BRAC (Bangladesh Rural Advancement Committee) initiative has empowered mothers of poor families through microcredit and education provision. The program also raised mother's awareness of gender sensitive behaviour and motivated her to feed boys and girls equally (Khatun et al. 2004). The result was positive as shown in a reduced gender gap in undernutrition. Furthermore, a study in India showed that earnings the mother had from work helped her to provide food security to the family (Bose 2011). It also improved her young daughter's access to animal-source foods, which many Indian girls had been denied due to cultural norms of son preference.

1.2.2 The linkages between religion and ethnicity, and nutrition

The mechanisms that link religion and ethnicity with nutrition were mostly unclear in previous studies of Benefice et al. (2006), Assefa et al. (2015), Omigbodun et al. (2010) and Khongsdier & Mukherjee (2003). However, these studies have certainly made their point, suggesting that cultural practices are probably the missing key in the linkages. As shown in Figure 1.1, religion and ethnicity may link to children's nutritional status by governing how the household spends its resources on food. The rules are not only related to what food to eat (food preferences) and what food not to eat (food avoidances or food taboos), but it might also extend to food distribution within the household, specifically when gender norms that are embedded in religious and ethnic identity are considered (see 1.2.1).

Hindus do not eat beef because cows are considered sacred in their belief. Jews and Muslims are prohibited from consuming pork as in their religion, pork is unclean and therefore should not be consumed. Furthermore, according to the Koran, Muslims should also avoid consuming blood, non-ritually slaughtered animals, and alcohol as these are "haram" or religiously forbidden (Benkheira 2000). These are examples of permanent food avoidances that those who adhere to the religion should conform with in daily life (den Hartog et al. 2006).

Food avoidances can also be temporary. These could take their form in religious fasting. Different to the declining tradition of fasting among Christians after the Reformation in Europe, Ramadan fasting among Muslims is still well practiced hundreds of years after the prophet

Muhammad. Islam mandates that every healthy adult Muslim should neither eat nor drink during daylight for a full month in Ramadan. There are exemptions to this rule, including for those who are pregnant. According to most interpretations of Islam, pregnant Muslim women are allowed to skip Ramadan fasting when health concerns arise (van Ewijk 2011). However, previous studies have shown that, for various reasons, many pregnant Muslim women keep fasting at least one day during Ramadan (Bilsen et al. 2016; Kiziltan et al. 2005). This has raised concern among scholars and health officials on whether such a restrictive dietary practice, despite being only temporary, is safe for the unborn to grow healthily (Almond & Mazumder 2011; van Ewijk 2011).

Aside from food avoidances, food preferences may also influence dietary intake of religious and ethnic-based social groups. In Indonesia, for example, the Batak tradition of *Jambar-Juhut* regulates how people from the Batak ethnic group distribute parts of animal meat to their relatives in cultural events, e.g., birth, marriage, and death ceremonies (Simatupang & Simatupang 2016; Siahaan 1993). The tradition might unintentionally enhance the cultural value of animal-source foods among the Batak. Such cultural practices might place the expensive animal-source foods high in priority and central to their dietary intake. Similarly, a negative food stigma may also affect food preferences and dietary intake within a social group. For example, cassava has been associated with food for the poor among people who live in Java, Indonesia, the origin of the Javanese (van Der Eng 1998). There is a possibility that in order to conform with their high socioeconomic status (SES), the affluent Javanese may consume less cassava than the poor Javanese. This kind of negative food stigma might then differ dietary intake of the high-SES Javanese from those with lower-SES background.

1.3 Research Objective and Questions

Section 1.1 of this thesis has highlighted three knowledge gaps. First, the lack of explanations on the emergence of malnourished adolescent boys in certain South Asia and Southeast Asia regions. Second, a dearth of studies examining the influence of women's empowerment on nutritional status, particularly in adolescence. Third, a call for research that could illuminate the pathways linking religion and ethnicity to nutritional status. The section has also introduced the Indonesian context. In Section 1.2, a theoretical framework has been sketched in form of Figure 1.1. The figure summarises hypothetical pathways describing how sociocultural-specific and economic factors may influence nutritional status in childhood and adolescence and how women's empowerment may play a role within. These two preceding sections guide the main research objective of this thesis, that is, "to examine how gender, religion, and ethnicity may influence nutritional status in childhood and adolescence (0–19 years of age) in Indonesia". In order to produce answers to the main research objective, this thesis offers four empirical chapters, each with specific research questions, which are formulated as follows.

First, the WHO released a report on adolescent nutrition in certain South Asia and Southeast Asia regions (WHO 2006a). Surprisingly, this report showed that even in patrilineal-patrilocal societies of Bangladesh (Shahabuddin et al. 2000) and India (Vijayaraghavan et al. 2000), where son preference was supposed to prevail, adolescent boys were more likely to be malnourished than girls. In Indonesia, more than 37% of 18-years-old boys were stunted in 2013, a number that is 11% higher than that of girls of the same age (MoH 2013). Such patterns of gender inequality—a greater number of malnourished adolescent boys than girls—diverges from studies of under-five children, where girls usually reported to have poorer nutritional status than boys (Bose 2011; Khatun et al. 2004). It raises questions on what would be the role of women's empowerment to improve this situation? Also, does women's empowerment help malnourished adolescent boys in the same way as for malnourished under-five girls? These thoughts motivate Chapter 2 in analysing the first research question (RQ1): "What is the influence of women's empowerment on adolescent nutritional status (10–19 years of age)?"

Second, Chapter 3 focuses on the role of mother's education in overweight amid a world that undergoes the Global Nutrition Transition (Popkin 1993; Popkin et al. 2012). There is a striking contrast between developed versus developing countries on the influence of the mother's education on overweight. Most literature from developed countries suggests that mother's education helps to reduce overweight in under-five children (Madden 2017; Ruiz et al. 2016; Apouey & Geoffard 2016). In contrast, a small-scale study in Bogor, Indonesia, showed that children of educated mothers were exposed more to overweight, most likely because they spent more of their pocket money on high-calorie foods during school hours (Ekawidyani et al. 2018). There have also been reports on gendered overweight in Indonesia. It was predicted that 5.9 million under-five Indonesian boys were overweight or obese in 2016, a number which is 1.1 million higher than those of girls of the same age (NCD-RisC 2017; Statistics Indonesia 2013). Analyses in Chapter 3 are, therefore, aimed to answer the second research question (RQ2): "What is the role of the mother's education in overweight and in influencing potential sibling inequalities within the household, e.g., by gender, birth order, and the number of siblings?". The chapter covers overweight in childhood and adolescence (0–19 years of age).

Third, Chapter 4 shifts to discourses on differences in nutritional status due to sociocultural factors related to religion. By taking maternal Ramadan fasting as an example, the chapter analyses how restrictive maternal dietary intake because of religious beliefs might influence nutritional status. Previous studies have suggested that starvation, including that of in form of fasting, increases toxicity in the mother's blood and thereby may create a hostile environment for the unborn to grow healthily (Herrmann et al. 2001; Malhotra et al. 1989; Paterson et al. 1967; Saleh et al. 1989). Considering this, Chapter 4 answers the third research question (RQ3) of this thesis: "Does maternal Ramadan fasting influence the nutritional status of Muslims during childhood and adolescence (0–19 years of age)?". Additionally, the chapter examines if the potential negative effects are reinforced or buffered later in life.

Fourth, Chapter 5 demonstrates how food preferences of different ethnic groups may influence dietary intake of school-aged children (7–12 years old). The chapter benefits from Indonesia's multi-ethnic context with different kinship systems (see Section 1.1). This feature allows the chapter to explore gendered food allocation patterns in different kinship systems. The chapter also takes a look at the association of household SES and types of food consumed within ethnic groups. This thesis has two reasons to assume that household SES also plays a role. First, the negative food stigma of cassava as the food for the poor, particularly among people who live in Java. Second, the high cultural value of the expensive animal-source foods among Batak people. Therefore, Chapter 5 examines the fourth research question (RQ4): "What is the influence of ethnicity on children's nutrition and how does this influence differ by gender and household SES?". The focus is on dietary diversity, an indicator of dietary intake, which is one of the immediate causes of nutritional status (see Figure 1.1). Previous studies have informed that consuming diverse types of food leads to better nutritional status than monotonous diet (Arimond & Ruel 2004; Hatløy et al. 2000; Nithya & Bhavani 2016).

1.4 Research Methodology

This thesis uses a quantitative approach to answer the main research questions. It uses secondary data from the Indonesian Family Life Survey (IFLS). IFLS collects a wealth of data on multiple health indicators and the socioeconomic condition of the Indonesian population. The IFLS sampling scheme consists of the 13 most populated provinces in Indonesia. They represent 83% of the national population in 1993. IFLS has unique features which sets it apart from other large quantitative datasets in Indonesia, including IDHS (Indonesia Demographic and Health Survey) and *Riskesdas,* or Indonesia Basic Health Research. First, IFLS is the largest ongoing household panel survey in Indonesia, while both IDHS and *Riskesdas* are repeated cross-sectional surveys. In this thesis, especially in Chapter 4, the panel design of IFLS is useful to incorporate life course approaches on the effects of maternal fasting as well as to develop quality data on birth date and to produce a coarse estimation on maternal Ramadan fasting in Indonesia (see Chapter 4 for details). Neither IDHS nor *Riskesdas* could facilitate these. Second, unlike IDHS, IFLS collected anthropometry data for children between age 5 and 14. This expands the usability of IFLS data in analysing nutritional status in late childhood (5–9 years of age) and early adolescence (10–14 years of age). Furthermore, by pairing this anthropometry data with individual food consumption, IFLS opens the opportunity to link dietary intake and nutritional status from childhood throughout adolescence (and potentially, from prenatal).

Currently, five IFLS waves have been conducted. The first IFLS was in 1993/1994. Since then, four follow-up surveys were carried out successively in 1997/1998, 2000, 2007/2008, and 2014/2015. IFLS-1 (1993/1994) interviewed 7224 households. In later waves, additional information from new-borns and split-off households were collected. A notable improvement came in IFLS-3 (2000). This third wave collected data on mother's bargaining power, ethnicity, and most importantly, individual food consumption. From IFLS-4 (2007/2008) onwards, a rough measure of religiosity is available (see Chapter 4 for details). The latest IFLS-5 (2014/2015) also surveyed consumption of high-calorie foods. This latest wave interviewed children and adults living in 16,930 households, over twice the number of interviewed households in IFLS-1 (1993/1994). IFLS has low sampling attrition because more than 92% of households in IFLS-1 (1993/1994) were successfully re-interviewed in IFLS-5 (2014/2015). The survey procedures and consent have passed the review process from IRBs (Institutional Review Boards) in the United States at RAND and in Indonesia at University of Indonesia (UI) for IFLS-1 (1993/1994) and IFLS-2 (1997/1998); and at University of Gadjah Mada (UGM) for the later IFLS-3 (2000), IFLS-4 (2007/2008), and IFLS-5 (2014/2015). More details of the IFLS can be found in Strauss, Witoelar & Sikoki (2016).

Each of empirical Chapters 2–5 consists of specific analytical methods that correspond to the research question the respective chapter aims to answer. Chapter 2 uses two WHO growth standard measures as indicators for adolescent nutritional status (10–19 years of age). These consist of height-for-age Z-scores (HAZ) and BMI (body mass index) for-age Z-scores (BAZ) (WHO 2006b; de Onis et al. 2007). The two indicators reflect stature and likewise other WHO indicators for nutrition (i.e., weight-for-age Z-scores or WAZ); these are standardised by sex and age. A score less than zero on these indices suggest a lower nutritional status than the WHO reference population. Aside from HAZ and BAZ, Chapter 2 analyses food consumption frequency which numerates how often, in terms of days in a week prior to the interview, an adolescent consumed certain types of food. Cluster robust OLS (Ordinary Least Square) regression models at the mother level are applied to analyse if empowered mothers improved adolescent nutritional status and whether mothers promoted gender equality within household. An additional exploratory analysis by using a series of *t*-tests was used to understand how women's empowerment may be associated with adolescents' diet.

To acquire the recent picture of overweight in childhood and adolescence (0–19 years of age) in Indonesia, Chapter 3 exclusively uses data from the latest IFLS-5 (2014/2015). This is also because only in the latest IFLS-5 (2014/2015), did the survey collect data on consumption of high-calorie foods, one of the logical channels through which children may develop unhealthy weight gain. In Chapter 3, those with BAZ ≥ 1 SD (standard deviation) are classified into the "overweight" group. Birth order dummies are then created to capture non-linear effects of birth order on child overweight. It consisted of three dummy variables, each for the "eldest", the "mid-child", and the "youngest" children. The three dummies are set to null for "only child". To disentangle the effects of birth order from that of number of siblings, the birth order dummies are then mean centred within family (see Chapter 3 for details). Cluster-robust logit regression models at mother level are used in the main analyses. The chapter also uses OLS to analyse within-sibling differences in consumption of high-calorie foods. Interactions effects between mother's education and sibling characteristics (i.e., sex, birth order, and number of siblings) are examined to understand the roles of mother's education in helping (or worsening) sibling inequalities in overweight.

Chapter 4 analyses the effects of prenatal exposure to Ramadan on stature from early childhood to late adolescence. The stature referenced in that chapter comprises three WHO growth standards of nutritional status: HAZ, WAZ, and BAZ. Similar to other secondary datasets, IFLS has very limited information on who among pregnant Muslim women were fasting during Ramadan. Therefore, an intention-to-treat (ITT) approach is introduced by using prenatal exposure to Ramadan as the proxy to maternal Ramadan fasting. Inspired by Majid (2015), Chapter 4 tries to improve the ITT estimations by classifying children based on the mother's religion-religiosity (see Chapter 4 for details). This is based on the mother's religion and her devotion to the Islamic Five Daily Prayers as one of the five pillars of Islam. The classification consists of "religious Muslims" for children of devoted Muslim mothers, "less religious Muslims" for children of Muslim mothers who did not comply fully to the Islamic Five Daily Prayers, and "non-Muslims" for those children of non-Muslim mothers. The chapter makes a rough estimation on maternal fasting rate by exploiting fasting behaviour from a small number of Muslims who were incidentally interviewed in Ramadan 1997/1998 and 2000. The classification of mother's religiosity based on their devotion to the Islamic Five Daily Prayers and the estimation on maternal fasting rate are two innovations that this chapter introduced over previous studies. Cluster-robust fixed-effects regression models at mother level are used to examine the effects of prenatal exposure to Ramadan on stature (i.e., nutritional status) for different life stages and for different religion-religiosity groups of the mothers.

Chapter 5 exploits ethnicity and food consumption data from IFLS-3 (2000) onwards. A Berry-Index score is constructed to measure dietary diversity. This index is based on the consumption frequency of five food groups (i.e., tubers, vegetables, fruits, animal-source foods, and dairy products) over a seven-day period before the interview. Analytical samples are from three ethnic groups: the bilateral Javanese, the patrilineal Batak, and the matrilineal Minangkabau. The chapter analyses school-aged children (7–12 years of age). This is to produce results that are relevant for school-based nutrition interventions. Cluster-robust OLS regression models at mother level are used to analyse ethnic group differences in dietary diversity and the consumption frequency of each of the five food groups. The latter is to examine the food composition that children consumed. To analyse the role of gender and household SES on dietary diversity, interaction terms between ethnic groups and gender, and between ethnic groups and household SES are added into the analyses.

Table 1.1 below summarises the analytical method of Chapter 2–5. It describes the outcome variables and the main explanatory variables for each research question. Details on how to construct and operate these variables are in the Data and Methods section of each empirical chapter.

Table 1.1. Summary of analytical methods of empirical Chapters 2–5

Chapter	Focus	Outcome variables	Explanatory variables	Data Analysis
Ch 2: RQ1	The influences of women's empowerment on gender inequality in adolescent nutritional status (10-19 years of age)	HAZ, BAZ, food consumption	women's empowerment indicators, sex	OLS, t-test
Ch 3: RQ2	The influences of the mother's education on sibling inequality in child overweight (0-19 years of age)	overweight (BAZ > 1 SD), consumption of high-calorie foods	mother's education, sex, birth order, number of siblings	logit regression, OLS
Ch 4: RQ3	The effects of prenatal exposure on nutritional status (stature) in childhood and adolescence (0-19 years of age)	HAZ, WAZ, BAZ	prenatal exposure to Ramadan, mother's religion-religiosity, age groups	fixed-effects (FE) regression

Table 1.1. Continued

Chapter	Focus	Outcome variables	Explanatory variables	Data Analysis
Ch 5: RQ4	The roles of gender and household SES in differing dietary intake of school-aged children (7-12 years of age) from ethnic groups with different kinship systems.	dietary diversity by using a Berry-Index score, food consumption	ethnic groups, sex, household SES	OLS

HAZ = height-for-age Z-scores; WAZ = weight-for-age Z-scores; BAZ = BMI (body mass index)-for-age Z-scores
OLS = ordinary least square

1.5 Thesis outline

To sum-up, this thesis examines the extent to which sociocultural factors may affect children's nutrition. It consists of four empirical chapters that uncover how gender, religion, and ethnicity influence nutritional status and dietary intake in childhood and adolescence. In the first two empirical chapters this thesis looks at the influence of women's empowerment. These chapters expand knowledge on how empowered mothers may shape the nutritional status of their children, specifically through the food consumption channel, e.g., consumption of high-calorie foods in Chapter 3. Both chapters analyse gender inequality in nutritional status hoping to seek indicative evidence on the probable mechanisms that may explain the emergence of malnourished adolescent boys in Indonesia. Chapters 4 and 5 shift to cultural practices embedded in religion and ethnicity, and how these may affect children's nutrition. Chapter 4 analyses whether restrictive maternal dietary intake in the form of Ramadan fasting affects the stature of Indonesian children. The chapter has a high societal relevance given that Indonesia is the country with the largest Muslim majority. Chapter 5 looks into differences in ethnic-related dietary intake of school-aged children. The chapter explores the linkages between ethnic-based kinship systems, e.g., Javanese-bilateral, Batak-patrilineal, Minangkabau-matrilineal, and gender inequality in dietary diversity. By considering the negative food stigma of cassava, as the food for the poor, among people who live in Java, and the high cultural value of the expensive animal-source foods in the Batak tradition, the chapter also investigates whether household SES may influence types of food that children consume. Chapter 6 concludes this thesis, summarising the main findings of Chapters 2–5 and presenting a general discussion on how these findings may fulfil the current research gaps and be relevant for society at large. The discussion then becomes the basis for a number of policy recommendations. The chapter closes with a review of the main limitations of the thesis and suggestions for further studies.

Chapter 2

Women's empowerment and gender inequalities in adolescent nutritional status

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Abstract

In contrast to the extensive knowledge on the association between women's empowerment and the nutritional status of children under-five, relatively little is known about the influence of women's empowerment on adolescent nutritional status. This study aimed to understand whether and how women's empowerment associated with adolescent nutritional status and possible gender inequalities therein. Data were from the Indonesian Family Life Survey (IFLS) over the period 1997 to 2015, consisting of 16,683 observations from 13,396 adolescents (10–19 years old) who were born in 6,781 families. Three indicators of women's empowerment were used: mother's education, mother's bargaining power, and mother's working status. OLS regression models with robust standard errors at mother level were applied to examine whether and how indicators of women's empowerment may influence adolescent nutritional status. Interaction terms were added to analyse whether and how the association might differ by gender. Results showed that mother's education and mother's working status were significantly associated with adolescent nutritional status, particularly with height-for-age z-scores (HAZ). Adolescents of educated mothers were taller, while those who were raised by blue-collar mothers were shorter. Although no gender differences were found for HAZ, gender differences for BMI-for-age z-scores (BAZ) were obvious. Boys were, overall, thinner than girls. Interaction effects showed smaller gender gap in BAZ among adolescents of educated mothers. However, further analyses indicated that the smaller gap might be because boys consumed instant noodles more often and that their fast foods consumption also increased in line with the number of years of education the mother received, thus suggesting gender bias in new disguise.

2.1 Introduction

Previous research has extensively shown that women's empowerment has a significant influence on the nutritional status of children under-five (Cunningham et al. 2015; Miller & Rodgers 2009; Smith et al. 2003). Empowered mothers are thought to have more awareness, capacity, and opportunities to articulate not only pro-child but also gender-sensitive behaviour linking to child nutritional status. Maternal education, for example, has been found to improve child nutrition through efficient use of information related to health knowledge (Thomas et al. 1991). Furthermore, education may increase women's opportunities to participate in the labour force and heighten her contribution to the family economy, thereby increasing her voice in intra-household bargaining processes (Sen 2009). Research has also found that in most cases, both the mother's working status and her bargaining power correlated with children's nutritional status (Roshita et al. 2013; Shroff et al. 2011; Toyama et al. 2001). Several studies have also reported that empowered mothers reduce inequalities in nutritional status between boys and girls (Bose 2011; Skoufias 1999; Khatun et al. 2004). For example, Bose (2011) showed that Indian mothers who have a job were able to provide more protein-rich food to improve the nutrition of their undernourished daughters, thus compensating the existing gender gap. However, whether these pro-child and gender-sensitive effects of women's empowerment on child nutritional status still hold when children grow into adolescence is less well-known.

The life stage of adolescence (10–19 years old) has certain characteristics which are different from childhood. During this life stage, boys and girls are exposed to a broader social environment beyond their family (Viner et al. 2012). They have more opportunities to express their preferences regarding nutrition and become more independent from their mother's food provision and supervision. However, the period of adolescence is often neglected as adolescents have typically been considered a low-risk group for poor health and have therefore received few healthcare resources and scant attention (Jong 2016). Undernutrition among adolescents and its gendered pattern is not uncommon, particularly in developing countries in Asia (WHO 2006a). In Indonesia, for example, more than 37% of eighteen-year-old Indonesian boys experienced stunting, a figure that was 11% higher compared to that of girls of the same age (MoH 2013). Such gender inequalities in adolescent nutritional status are very different from what has been found in studies of children under-five in which girls usually have a lower nutrition and health condition than boys (Bose 2011; Khatun et al. 2004). Interestingly enough, patterns of undernourished adolescent boys were often found in regions where son preference is the norm, cf. Dasgupta (2016), Kevane & Levine (2000) and Koolwal (2007). The distinctive characteristics of the adolescent life stage and the shifting gender inequalities that may occur during this period offer an opportunity to advance current knowledge on the associations between women's empowerment and the nutritional status of children beyond childhood.

This study aimed to extend the limited knowledge on women's empowerment and adolescent nutritional status and the possible gender inequalities therein. The study focused on three indicators of women's empowerment, which have been corroborated as meaningful in recent studies, i.e., mother's education, mother's bargaining power, and mother's working status (Phan 2016). The study used height-for-age z-scores (HAZ) and BMI-for-age z-scores (BAZ) as outcome variables measuring adolescent nutritional status. The analytical sample derives from the Indonesian Family Life Survey (IFLS) covering a period 1997-2015 and includes 16,683 observations from 13,396 adolescents (10–19 years of age) who were born in 6,781 families. Being a modernising middle-income country in Southeast Asia and the fourth largest country in the world in terms of population, Indonesia offers an interesting case since it exhibits both traditional South-East Asian and increasingly modernised and globalised characteristics.

The remainder of this paper starts with a theoretical background and summary of prior research on the relationship between women's empowerment and adolescent nutrition. Next, the Indonesian context is briefly described, and context-specific testable hypotheses are formulated. Subsequently, data, measures, and methods are discussed. The results section then presents OLS regression models examining the main effects of women's empowerment and its interaction effects with gender on adolescent nutritional status. Additional analyses on comparing food consumption of adolescent boys and girls are presented to help with understanding gender inequalities and the buffering thereof. Finally, results are summarised and interpreted and discussed in the light of previous theory and empirical evidence.

2.2 Background: women's empowerment, child and adolescent nutritional status

The literature on women's empowerment and its effects on social and health behaviours vary when it comes to defining what exactly women's empowerment is. Proposed definitions diverge according to the domain of empowerment and in the emphasis placed on certain aspects. Kabeer (1999), for example, defined empowerment as "the expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them". Most definitions in the literature have linked women's empowerment with notions of power, agency, control, and decision-making that underline the opportunities of women to make choices and the ability to manage their life (Cunningham et al., 2015). Malhotra et al. (2005) produced a thorough review to develop common indicators of women's empowerment. This review, as well as other studies, e.g., Mosedale (2005) and Odutolu et al. (2003) , clearly showed that women's empowerment is highly context-specific, hence constructing common indicators is problematic. However, some indicators of women's empowerment constantly re-emerge in recent studies. These indicators are mother's education, mother's bargaining power, and mother's working status (Phan 2016). The capacity that empowered mothers have in managing their lives not only pertains to themselves but may also encompass the lives of other family members, including their children.

Many studies have linked indicators of women's empowerment such as mother's education with nutritional status of under-five children (Glewwe 1999; Semba et al. 2008; Thomas et al. 1991). In contrast, very few studies have examined the link between women's empowerment and nutritional status of adolescent children. Different explanations describing the mechanisms underlying the women's empowerment-child nutrition link have been given. First of all, an often-evoked mechanism focuses on the positive effects of mother's education on her children health outcomes. It is usually inferred that the more years the mother spent in school, the better she is prepared to enter the labour market and to find a better-paying job. Moreover, it is also assumed that maternal schooling indirectly improves her access to information on sound health practices and behaviour (Burroway 2016). Educated mothers are thought to benefit their children through effective health-care utilisation and openness to new diets and nutrition (Smith & Haddad 2000; Smith et al. 2003). Secondly, empowerment is often equated with women's working status. Work, and the remunerative benefits that go with it, give women economic independence and increase her contribution to household resources that could be spent on her children's nutrition and health needs. Sen (2009) suggested that the mother's working status also increases her control over household income and resources and raises her voice in intra-household bargaining processes around these resources. However, women's work may also have negative consequences for child health because of the more limited time she can spend with the children and less supervision she can give to what the children eat and what activities they do (Cunningham et al. 2015; Engle et al. 1999). Such lack of care may negatively affect children's nutritional status. This negative effect is thought to be even worse for children who live in poor households where mothers have to work in a low-paying job with possibly long working hours to contribute to the family income (Roshita et al. 2013; Toyama et al. 2001). A third mechanism through which women's empowerment may influence child nutrition is bargaining power. Richards et al. (2013) and Thomas et al. (2002) have argued that mother's bargaining power positively correlates with pro-child resource flows. An example, although not directly related to nutritional status, was a study in Benin that showed that mother's income increased her bargaining power to spend money on children's bed-nets to protect them from malaria (Rashed et al. 1999). In general, previous empirical research has mainly found positive effects of women's empowerment on child nutrition. However, as has also been argued, these findings should be carefully interpreted because spurious correlations may occur due to empowered mothers usually coming from better-off households which could overstate the effect of women's empowerment on health behaviour and children's health outcomes (Parashar 2005).

While studies on the association between women's empowerment and child nutritional status abound, literature discussing gender differences therein are much less. The three studies that the authors were aware of, which have studied the gendered linkage between women's empowerment and child nutritional status, show however interesting findings that require further research (Bose 2011; Skoufias 1999; Khatun et al. 2004). Skoufias (1999) studied whether the number of years the mother spent in school affects the WAZ of under-five children in Indonesia. The study found that nutrition lag of girls compared to boys at age 2–5 years was only compensated when the mother had more than 12 years of schooling. Khatun et al. (2004) reported that the BRAC (Bangladesh Rural Advancement Committee) initiatives on microcredit and education provision to empower poor women strengthened their economic opportunities and benefited their undernourished daughters. During the three-round surveys, the study found that the proportion of stunting for an average four-year-old girl had decreased from 74.1% in the first round (June–August 1995) to 70.4% in the third round (January–May 1996) reducing the gap to merely 2.2% when compared to boys of the same age. The study inferred that despite the households' low socioeconomic status, the BRAC initiatives successfully raised mothers' awareness on gender-sensitive behaviour to feed boys and girls equally. Bose (2011) showed that in India where a cultural norm of son preference prevails, girls under-five had a poorer nutritional status than boys. The study indicated that on average, these girls consumed less often milk products and animal-source foods (e.g., meat, fish, and eggs) compared to boys. However, in households where the mother had a job, girls were given meat, fish, and eggs more frequently, although not more milk products, thus indicating a greater extent of equality in food distribution among sons and daughters.

2.3 The Indonesian context

Located in Southeast Asia, Indonesia is the fourth largest country in the world in terms of population. The world's largest archipelago is the home for 250 million inhabitants of different religions and ethnic groups (Statistics Indonesia 2011). More than 87% of Indonesians are

Muslims. The Javanese and Sundanese are the two largest ethnic groups comprising 40% and 15% respectively. Approximately 65% of the Indonesian population lives on the islands of Java and Bali, which are more developed compared to other islands in Indonesia. After the late 1990s Asian Economic Crisis, Indonesia underwent major economic development. The emerging economy's GNI (Gross National Income) grew nearly six-fold from merely USD 580 in 2000 to USD 3,440 in 2015 (Elder & Ransom 2003). However, this vast economic growth was unable to elevate the country from undernutrition. The 2013 Basic Health Research report showed that more than half of the Indonesian adolescents had a dietary intake of less than the national RDA (Recommended Dietary Allowance). The report also showed that among late adolescents, 31.4% was stunted, and 9.4% had lean BMI (MoH 2013).

A large regional variation in gender norms and sex imbalances exists in Indonesia, but there is less evidence of son preference than in many other Asian societies (Guilmoto 2015). Indonesia, in general, has a bilateral kinship system and therefore women have a relatively high status (Frankenberg & Thomas 2001; Stoler 1977). In fact, the history of female rulers in Indonesia can be traced back to the ancient kingdom of Majapahit hundreds of years preceding the colonial era (George 1968). The diverse religions, ethnicities, and cultures of Indonesia do not seem to undervalue women's status, as is indicated in bride-prices, residence patterns after marriage, and interracial unions (Reid 1988). There was some evidence of gender gaps in education in the past, but in recent years gender differences have diminished in primary education and are starting to narrow in secondary education (Kevane & Levine 2000). A strong conditioning in gender roles took place when the New Order regime ruled the country from 1968–1998. The regime encouraged family planning to accelerate the nation's development by promoting the 'small family norm' consisting of husband and wife with two children (Niehof & Lubis 2003). This norm centred on the father as the main income earner and the mother as the husband's supporter, the nurturer, and the social and moral caretaker of the family (Rodenburg et al. 2000). Thus shaping the gendered division of labour within the family until today, which to some extent restricts women's space outside the household but gives her much authority in domestic matters.

Literature that specifically discusses gender gaps in nutritional status in Indonesia is rare. Although the differences were not always statistically significant, studies on nutritional status in Indonesia indicated that males often have a lower nutritional status than females. Sujarwoto & Tampubolon (2013), for example, showed that compared to girls (with average age of 5.9 years), boys of the same age were –0.075SD (standard deviation) shorter in terms of HAZ and –0.003SD thinner in terms of WAZ. The Ministry of Health Republic of Indonesia (2013) indicated that boys are more at risk of being undernourished as stunting at 18 years old was more common among boys than among girls (boys: 37.4%; girls: 26.2%). A small scale study in Bogor and Indramayu district also indicated that males were thinner than females in adulthood (Riyadi et al. 2006). This study found that 14.3% of adult males in poor households in Bogor had a BMI of less than 18.5 compared to 12.3% of adult females.

2.4 Hypotheses

There is little research investigating the association between women's empowerment and adolescent nutritional status. However, the mother's empowerment-child nutrition link during childhood may be expected to continue into adolescence though becoming less in strength. Thus, it is expected that:

Hypothesis I:
Indicators of women's empowerment, that is, mother's education, mother's working status and mother's bargaining power, have positive effects on adolescent nutritional status. However, mother's working status may also have negative consequences because women have less time to supervise their children's diets.

Indonesia has a bilateral kinship system, but instead of equal nutritional status, research showed that adolescent boys were undernourished (MoH 2013), thus indicating gender inequalities in nutritional status during adolescence. It is interesting to know whether women's empowerment compensated such gender inequalities in similar ways as those found in studies of under-five children in Indonesia, Bangladesh and India (Bose 2011; Skoufias 1999; Khatun et al. 2004). Considering that women's empowerment may increase a mother's awareness, capacity, and opportunity to articulate gender-sensitive behaviour, this study expects that:

Hypothesis II:
Gender gaps in nutritional status between boys and girls are less for adolescents whose mothers are more empowered.

2.5 Data, measurements, and methods

This study used data from the Indonesian Family Life Survey (IFLS). The IFLS is the largest ongoing panel survey in Indonesia collecting a wide array of data on socioeconomic and health indicators on individuals, households, and communities. The first wave of the survey was conducted in 1993/1994. Since then, four follow-up surveys have been undertaken in 1997/1998, 2000, 2007/2008, and 2014/2015 subsequently. The IFLS sampling scheme consists of the 13 most densely populated provinces in Indonesia representing 83% of the 1993 Indonesian population. The sample of IFLS–1 (1993/1994) consisted data from 33,081 individuals living in 7,224 households. The follow-up IFLS waves also collected data from new members of these households including the new-borns and also from the split-off households, which mostly consisted of those who were then married and had established their family outside the original household. The re-contact rate in IFLS–5 (2014/2015) was 92% of all households in IFLS1 (1993/1994) including its split-offs. This high re-interviewed rate contributed significantly to the data quality as the high rates lessened the risk of bias due to non-random attrition. Strauss, Witoelar & Sikoki (2016) documented the IFLS in detail.

The current IFLS dataset contained data from 83,700 individuals participating in at least one of the IFLS waves. The data allowed this study to trace biological parents of 37,375 individuals. Because the interest is in nutritional status in adolescence (age 10–19 years old), the study excluded 19,224 individuals whose height and weight measurements were not collected during that age. The study further excluded 179 adolescents whose HAZ or BAZ were biologically implausible according to the WHO growth reference chart (de Onis et al. 2007). These exclusion processes produced an initial sample of 25,278 observations from 17,972 adolescents who were born in 8,687 families. The inclusion of the explanatory variables and control variables into the analyses reduced the sample further. This study excluded 3,153 adolescents due to missing values on indicators of women's empowerment particularly because the indicator for mother's bargaining power was available from IFLS–2 (1997/1998) onwards only. Therefore, all observations from IFLS–1 (1993/1994) were excluded. A further reduction of 1,423 adolescents due to missing values in the control variables, mainly because the father was absent during the collection of height and weight measurements, completed the sample construction. Therefore, the final analytical sample consisted of 16,683 observations from 13,396 adolescents who were born in 6,781 families.

Outcome variables

This study analysed two outcome variables: adolescent nutritional status (HAZ and BAZ) and food consumption. Adolescent nutritional status is the primary outcome variable used to test the proposed hypotheses. The additional food consumption variable is analysed to understand the probable underlying causes of the expected reduced gender gaps in nutritional status among adolescents of empowered mothers.

In each IFLS wave, trained nurses were assigned to collect multiple health measurements of household members who were present during the survey. The measurements included height (cm) and weight (kg) up to a single digit decimal. For indicators of adolescent nutritional status, the authors standardised height and weight into HAZ and BAZ based on the WHO child's growth references (de Onis et al. 2007). This Z-scores standardisation controlled biological variations in growth and produced linear indicators which are more comparable across gender and age (Wang and Chen, 2012). The standardisation also simplified identification of biologically implausible heights and BMI measures. It is worth noting that in this study, HAZ reflects long-term nutritional status, which is partly inherited from earlier life stages, while BAZ reflects current nutritional status and is more sensitive to the life circumstances experienced at adolescence. The study did not use other anthropometric related nutritional status indicators such as weight–for–length Z-scores (WLZ) and WAZ because these indicators were available only for under-five children and under-ten children respectively.

Data on food consumption were available in the last three waves starting from IFLS–3 (2000). This basic information on food consumption recorded the number of days an individual was consuming particular types of food in the week prior to the interview. The IFLS–3 (2000) and IFLS–4 (2007/2008) collected data on ten food types including sweet potatoes, eggs, fish, meat, dairy products, green leafy vegetables, banana, papaya, carrot, and mango. In IFLS–5 (2014/2015), another seven food types were added consisting of fast food, instant noodles, soft drinks, chilli sauce, fried snacks, rice, and sweet snacks. The authors rescaled the number of days in IFLS–3 (2000) into 0 "did not consume", 1 "1 day", 2.5 "2 to 3 days", 5 "4 to 6 days", and 7 "every day" to harmonise the data with the continuous scale on the number of days that more recent IFLS waves used. Since adolescents rarely consumed all these food types in a week, the study aggregated 14 food types into 8 food groups consisting of animal-source foods (eggs, fish, meat), vegetables (green leafy vegetables, carrot), fruits (banana, papaya, mango), dairy products, fast foods, instant noodles, soft drinks, and snacks (fried snacks, sweet snacks). Sweet potatoes, rice, and chilli sauce were not included because the first two are carbohydrate sources, which most Indonesian adolescents eat at least once every day and chilli sauce is an additional dish that is consumed only in small portions and therefore, the effect on nutritional status would be minor if existing at all.

Explanatory variables

The two key explanatory variables that this study used are gender and three indicators of women's empowerment: mother's education, mother's bargaining power, and mother's working status. The gender variable was constructed with girls as the reference group because in Indonesia adolescent boys are expected to experience undernutrition. Mother's education was measured as the number of years of schooling that she completed. This indicator is a continuous scale ranging between 0 and 12 years of schooling (0 for "never went to school"; 12 for "high school graduates and mothers who had some years of higher education"). The mother's bargaining power indicated the mother's voice in power relations with other family members when it comes to household decision making. This indicator was constructed from the IFLS "household expenditure and use of time" module (Frankenberg & Thomas 2001). The original module consisted of 17 questions. However, since not every household ever made decisions on all items, this study only used the 13 questions that had the least missing values. These questions are on decisions related to "food eaten at home", "daily purchases such as cleaning supplies", "own clothes", "spouse's clothes", "children's clothes", "children's education", "children's health", "large expensive purchases (e.g., fridge or TV)", "giving money to own parents/family", "giving money to own spouse's parents/family", "gifts for parties/weddings", "time the wife spends socialising", and "if the mother allowed to work". For each question, the authors assigned 0 if the mother did not contribute to making the decision, 1 if the mother contributed, but did so jointly with other members of the household, and 2 if the mother took the decision alone. By using a similar approach to that of Shroff et al. (2011), the authors assigned the first PCA (Principle Component Analysis) factor score from the 13 questions as the composite value for mother's bargaining power. A dummy variable was used to categorise mother's working status and distinguish between mothers who did not work and mothers who had a job. However, since the association of mother's working status and adolescent nutritional status may also have differed by the mother's type of job, the authors constructed another dummy to specify whether the mother's job was blue-collar or white-collar. The authors classified mothers who worked as "unpaid family worker", "casual worker in agriculture", "casual worker in non-agriculture" into the blue-collar category and mothers who worked as "professional/self-employed", "government worker", and "private worker" into the white-collar category.

Control variables

Six groups of control variables were included to reduce estimations bias on nutritional status due to possible confounders. These six groups were: 1) the mother's and the father's height and BMI to control for genetic factors, 2) Personal Consumption Expenditure (PCE) to control for family socioeconomic status (SES), 3) birth order and sibling size to control for family composition, 4) adolescents' activity to control for energy expenditure, 5) residential area to control for regional differences, and 6) IFLS waves fixed effects to control for socioeconomic changes over period of this study.

Genetic factors are unarguably influencing a person's height and weight (Silventoinen et al. 2007; Liu et al. 2015). The inclusion of both the mother's and the father's height and BMI as control variables is expected to reduce variations in nutritional status due to genetic factors inherited from both parents.

Other factors such as the family SES may also have affected nutritional status (Engle et al. 1999; Thomas 1994; Heilmann 2013). The extent of disposable financial resources available to the family may enlarge access to quality food, health facilities, and a better living environment. The IFLS collected data on expenditure and assets, which can be used to construct a family SES indicator. Filmer & Pritchett (2001) suggested when expenditure and asset data are available, the use of expenditure for the family SES indicator is preferable. The authors closely followed Witoelar (2009) to calculate nominal Personal Consumption Expenditure (PCE) from the IFLS data. With a similar approach to what has been described in Strauss et al. (2004), the authors then calculated real PCE in million Rupiah (1 million Rupiah = USD 83,77 in 2014) by using the capital city Jakarta 2014 as the baseline. The use of real PCE ensured comparability of family SES across regions (robust to regional price differences) and across IFLS waves (robust to the inflation rate).

Related to family SES, the share of resources (financial, goods, time, etc.) that a person received may have differed by family composition factors such as birth order and sibling size (Bras et al. 2010; Booth & Kee 2009; Stradford et al. 2016). For this reason, the authors also included birth order and sibling size for additional control variables. Dummies were used for birth order and a continuous scale for sibling size to reduce potential multicollinearity between the two variables (Booth & Kee 2009). Sibling size represents the number of all living biological children (0–19 years of age) of a family in each IFLS wave.

Previous studies showed that the burden of doing school and work together might place the health of school-aged children at risk, particularly if their food consumption does not match such energy-demanding activities (Wolff & Malikib 2008; Gumus & Wingenbach 2016). The authors included dummies for adolescents' activities to control for differences in energy expenditure. The IFLS recorded whether a person was involved in school and work activity in the last month before the survey. The authors coded this activity into dummies consisting of four categories: "neither went to school nor work", "went to school only", "went to work only", and "went to school and work".

Regional differences is another important factor that affects health (Suryadarma et al. 2006), possibly through spatial differences in food availability and access to health facilities. This study used residential area variables to control for regional differences. The authors included a dummy for urban/rural and another dummy for residence on Java-Bali versus residence in other regions.

Aside from all the factors above, an important factor that may have influenced nutritional status is socioeconomic changes (Cai 2014; Delfino et al. 2016). This macro factor is multidimensional, including, but not limited to, transitions in nutrition and dietary practices, such as the global nutrition transition (Popkin et al. 2012) and improvements in health facilities over time. Dummies were included to represent the IFLS waves as year fixed effects to control for socioeconomic changes.

Table 2.1. Sample characteristics

	IFLS 2 (1997/1998)		IFLS 3 (2000)		IFLS 4 (2007/2008)		IFLS 5 (2014/2015)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p
adolescents' characteristics:[a]									
gender									
boys %	49.86		50.68		50.70		51.46		0.57
girls %	50.14		49.32		49.30		48.54		
age (in years)	14.25	(2.52)	14.52	(2.64)	14.31	(2.60)	14.11	(2.51)	<0.01
nutritional status									
HAZ	-1.77	(1.03)	-1.77	(0.97)	-1.61	(1.06)	-1.37	(1.01)	<0.01
BAZ	-0.69	(1.08)	-0.76	(1.09)	-0.66	(1.22)	-0.49	(1.29)	<0.01
activities									
neither went to school nor work %	10.03		10.90		8.05		4.39		<0.01
went to school %	79.31		65.20		73.30		76.95		
went to work %	6.32		12.68		8.75		5.78		
went to school and work %	4.34		11.23		9.89		12.88		
food consumption (days per week)*									
animal-source food			2.19	(1.39)	2.74	(1.29)	2.31	(1.30)	<0.01
vegetables			3.46	(1.48)	3.13	(1.56)	1.95	(1.59)	<0.01
fruits			2.29	(1.47)	1.24	(1.14)	0.83	(1.01)	<0.01
milk			1.21	(2.29)	1.64	(2.41)	1.38	(2.32)	<0.01
fast food							0.37	(1.09)	
instant noodle							2.24	(2.12)	
carbonated beverages							0.50	(1.18)	
snacks							3.13	(2.11)	
women's empowerment:[b]									
mother's education	2.42	(3.91)	2.86	(4.15)	5.03	(4.71)	7.18	(4.22)	<0.01
mother's bargaining power	0.11	(1.74)	0.13	(1.69)	-0.04	(1.52)	0.47	(2.06)	<0.01
mother's working status									
did not work %	42.30		31.32		31.87		29.12		<0.01
blue-collar worker %	13.59		19.08		29.71		22.37		
white-collar worker %	44.11		49.60		38.41		48.51		

Table 2.1. Continued

	IFLS 2 (1997/1998)		IFLS 3 (2000)		IFLS 4 (2007/2008)		IFLS 5 (2014/2015)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p
other characterstics:[b]									
parental characteristics									
mother's height	150.31	(5.36)	150.35	(5.25)	150.73	(5.29)	151.12	(5.24)	<0.01
mother's BMI	23.27	(4.01)	23.57	(4.05)	24.60	(4.30)	25.64	(4.41)	<0.01
father's height	160.76	(5.85)	160.78	(5.86)	161.49	(6.03)	162.28	(6.03)	<0.01
father's BMI	21.75	(3.14)	21.86	(3.33)	22.59	(3.63)	23.16	(3.73)	<0.01
family characteristics									
sibling size	2.86	(1.31)	3.10	(1.44)	2.93	(1.34)	2.64	(1.15)	<0.01
real PCE (in million rupiah)	0.87	(2.24)	0.83	(0.95)	0.88	(0.81)	0.97	(0.78)	<0.01
residential area									
urban %	48.79		46.68		51.95		58.59		<0.01
rural %	51.21		53.32		48.05		41.41		
Java–Bali %	62.71		62.10		62.56		58.86		0.01
outside Java–Bali %	37.29		37.90		37.44		41.14		
[a] N of adolescents observed =	3,528		4,497		4,124		4,534		
[b] N of families observed =	2,156		2,768		2,874		3,352		

SD = standard deviation; p = p-value
ANOVA test was used to analyse differences by IFLS waves of all continuous-scale characteristics
Chi^2 test was used to analyse association between each dummy(ies) characteristics and IFLS waves
[*] some observations have missing value, the actual N of adolescents observed can be found in Table 2.4

Sample characteristics

Table 2.1 summarises the sample characteristics of this study in three subsections by IFLS wave: 1) adolescent characteristics, 2) women's empowerment, and 3) other characteristics. In the section on "adolescent characteristics", it is clear that differences in the percentage of boys and girls by IFLS wave were not significant. However, average age did differ. Adolescents in the latest IFLS5 (2014/2015) were younger than those in the previous three waves (on average, 14.11 years old). In general, the table showed a significant trend in the improvement of nutritional status. Only during the period of the Asian economic crisis, did the BAZ slightly decrease from –0.69SD in IFLS–2 (1997/1998) to –0.76SD in IFLS–3 (2000). Despite the fact that adolescent nutritional status improved over time, the average HAZ and BAZ were negative, meaning that the nutritional status of Indonesian adolescents is still below the WHO growth reference. Thus, these numbers underlined the high degree of undernourishment in Indonesia, at least among adolescents. There is a significant difference in adolescent activities by IFLS wave. In IFLS–3 (2000), fewer adolescents went to school than in IFLS–2 (1997/1998) indicating high rates of school drop-out that may relate to the Asian economic crisis of the late 1990s (Frankenberg et al. 1999). The percentage of adolescents who went to school then increased again but did not recover to the level before the crisis. Interestingly, the percentage of adolescents who "went to school and work" increased. The percentage grew almost threefold from 4.35% in IFLS–2 (1997/1998) to 12.9% in IFLS–5 (2014/2015). Table 2.1 shows a significant decrease in consumption of vegetables over the last 15 years. Where previously the average number of days those adolescents consumed vegetables in a week is 3.46 in IFLS–2 (2000), the number dropped to 1.95 in IFLS–5 (2014/2015). The situation is the same for the consumption of fruits for which the consumption fell from 2.29 in IFLS2 (2000) to 0.83 in IFLS5 (2014/2015). Some food groups were available in IFLS–5 (2014/2015) only, and therefore, no statistical test can be applied, but it should be noted that the consumption of high-calorie foods such as instant noodles and snacks were high (instant noodles: 2.24; snacks: 3.13). In the "women's empowerment" subsection, the table shows that mother's education increased significantly over time from on average 2.42 years in IFLS–2 (1997/1998) to 7.18 years in IFLS–5 (2014/2015). In contrast to the improvement in years of schooling, mother's bargaining power relatively remained at the same level in all waves until IFLS–5 (2014/2015) when there was a significant increase to 0.47SD. Table 2.1 also showed that more women were participating in the labour force. More than 70% of all women were working in IFLS–5 (2014/2015) in contrast to 57.7% in IFLS–2 (1997/1998). In the "other characteristics" subsection, the authors observed that both parental height and BMI increased over time indicating improvement in adult nutritional status. However, there was a trend that mothers became gradually more overweight as the average mother's BMI in IFLS–5 (2014/2015) is over 25. A trend towards smaller family size is noticeable as sibling size became smaller from 2000 onwards from 3.10 in IFLS–3 (2000) to 2.64 in IFLS–5 (2014/2015). The Asian economic crisis might be the reason why the average PCE is at its lowest in 2000 (IFLS–3) (i.e., 0.83 million Rupiah) before steadily increasing to 0.97 million Rupiah in IFLS–5 (2014/2015). Regarding the residential area, the majority of the families in the sample lived in urban areas and in Java and Bali (urban: 58.59%; Java–Bali: 58.86% in IFLS5 (2014/2015)).

Methods

The analyses were divided into two parts. In the first part, the two proposed hypotheses are examined. The second part is an exploratory analysis to further understand the linkages between women's empowerment and gender differences in food consumption.

The first part started with a basic model as follows:

$$Y_{im} = \beta_1 \, sex_{im} + \beta_2 \, X_{im} + \varepsilon_{im} \quad (1)$$

Where Y_{im} is the nutritional status of adolescent i who was born in family m, sex_{im} is the adolescent's gender, and X_{im} are the control variables. This null model was estimated to examine whether gender inequalities in nutritional status during adolescence occurred. Stepwise inclusions of each indicator of women's empowerment followed the basic model and produced three models with main effects of women's empowerment as follows:

$$Y_{im} = \beta_1\, sex_{im} + \beta_2\, medu_m + \beta_3\, X_{im} + \varepsilon_{im} \quad (2)$$

$$Y_{im} = \beta_1\, sex_{im} + \beta_2\, medu_m + \beta_3\, mbargain_m + \beta_4\, X_{im} + \varepsilon_{im} \quad (3)$$

$$Y_{im} = \beta_1\, sex_{im} + \beta_2\, medu_m + \beta_3\, mbargain_m + \beta_4\, mwork_m + \beta_5\, X_{im} + \varepsilon_{im} \quad (4)$$

Where $medu_m$ is the mother's education, $mbargain_m$ is the mother's bargaining power, and $mwork_m$ is the mother's working status. Models 2–4 were estimated to examine whether women's empowerment positively correlates with adolescent nutritional status (hypothesis I). Further stepwise inclusions of the interactions between gender and women's empowerment were then performed. The models with interactions were estimated to examine whether gender inequalities in nutritional status are less for adolescents of empowered mothers (hypothesis II). This process produced Models 5–7 as follows:

$$Y_{im} = \beta_1\, sex_{im} + \beta_2\, medu_m + \beta_3\, mbargain_m + \beta_4\, mwork_m + \beta_5\, (sex_{im} \times medu_m) + \beta_6\, X_{im} + \varepsilon_{im} \quad (5)$$

$$Y_{im} = \beta_1\, sex_{im} + \beta_2\, medu_m + \beta_3\, mbargain_m + \beta_4\, mwork_m + \beta_5\, (sex_{im} \times medu_m) + \beta_6\, (sex_{im} \times mbargain_m) + \beta_7\, X_{im} + \varepsilon_{im} \quad (6)$$

$$Y_{im} = \beta_1\, sex_{im} + \beta_2\, medu_m + \beta_3\, mbargain_m + \beta_4\, mwork_m + \beta_5\, (sex_{im} \times medu_m) + \beta_6\, (sex_{im} \times mbargain_m) + \beta_7\, (sex_{im} \times mwork_m) + \beta_8\, X_{im} + \varepsilon_{im} \quad (7)$$

For estimating the seven models above, multivariate linear regressions were used. The final analytical sample was nested in two ways. First, it was nested within adolescents because some adolescents were interviewed in several IFLS waves. Second, within-family nesting occurred because clusters of adolescents from the same families who had the same biological parents existed. Cameron & Miller (2015) and Pepper (2002) suggested to cluster the standard errors ε_{im} of such multiple nested samples at the highest level of aggregation to produce inferences which are robust to intra-cluster correlations. Since within-family clustering is the highest level of aggregation, standard errors ε_{im} of the multivariate linear regressions were then clustered at the within-family level or mother level. The Akaike Information Criterion (AIC) was used to select the most parsimonious models for both HAZ and BAZ.

The second part of the analyses divided the sample by gender in order to perform a series of exploratory analyses using two-sample t-tests on food consumption. These simple t-tests were performed only for women's empowerment indicators in which the interaction with gender was significant. The results were then compiled into a table consisting of eight food groups.

2.6 Results

Table 2.2 presents multivariate linear regression models for the determinants of HAZ. The main question was whether and how the three different indicators of women's empowerment were associated with HAZ. In Model 1, the gender of the adolescent and all control variables were included. Model 1 and the subsequent models in Table 2.2 indicated that there was no significant gender difference in HAZ. Model 1 also showed that parental characteristics were positively related to HAZ. However, this pertained more to parental height than to BMI. The association between mother's height and adolescents' HAZ, for example, was more than twice that of mother's BMI (e.g., mother's height vs mother's BMI: b = 0.053; p-val. < 0.01 vs b = 0.023; p-val. < 0.01). Sibling size negatively influenced HAZ (b = –0.068 per additional sibling; p-val. < 0.01); the more siblings an adolescent had, the shorter his or her height was, indicating processes of resource dilution in the family. PCE was positively correlated with HAZ (b = 0.036; p-val. < 0.01) pointing out that family SES has a significant role in improving HAZ. Table 2.2 did not find a significant effect of the activity pattern of adolescents on their HAZ. Those adolescents who lived in an urban area and those who lived in Java and Bali were considerably taller (urban: b = 0.199, p-val. < 0.01; Java and Bali: b = 0.113; p-val. < 0.01) which might indicate spatial differences in food consumptions and health services across the archipelago. Significant improvements of HAZ in the last two waves of IFLS also occurred, with HAZ in IFLS–5 (2014/2015) being higher as compared to IFLS–2 (1997/1998) (b = 0.176; p-val. < 0.01).

Models 2–4 in Table 2.2 comprise the main effects of the three empowerment indicators in a stepwise manner. The models reveal that mother's education had a positive effect on HAZ (b = 0.009 per additional year of schooling; p-val. < 0.01). No significant effects were found for mother's bargaining power (Model 3). Compared to adolescents whose mother did not work, adolescents who were raised by blue-collar mothers were shorter (b = –0.064, p<0.05 in Model 4). The same association also applied to adolescents of white-collar mothers although the negative effect was much less and not significant (b = –0.024 in Model 4).

Models 5–7 in Table 2.2 included interaction terms between the women's empowerment indicators and gender. However, none of these interactions was significant. Moreover, the models with interactions did not improve over Model 4, which included the main effects only, as is shown by the lowest AIC score (AIC = 43,248.204). Thus, Model 4 was the most parsimonious model.

Table 2.3 shows multivariate regression analyses for BAZ. In contrast to HAZ, all models in Table 2.3 strongly indicated gender differences in BAZ. Model 1 suggested that boys were thinner than girls in terms of BAZ (b = –0.313, p-val. < 0.01). Model 1 also suggested a positive effect of mother's and father's BMI on the adolescents' BAZ (mother's BMI: b = 0.059, p-val. < 0.01; father's BMI: b = 0.073, p-val. < 0.01). Such significant effects were not found for both mother's and father's height. Similar as in Table 2.2, sibling size was negatively associated with BAZ (b = –0.030 per additional sibling, p-val. < 0.01). PCE positively influenced BAZ as each additional one million Rupiah increased the BAZ by 0.024SD (b = 0.024, p-val. < 0.05). Adolescents' activities had a significant impact on their BAZ. Compared to those who "neither went to school nor work", adolescents who "went to school" or "went to school and work" were significantly thinner (went to school only: b = –0.283, p-val. < 0.01; went to school and work: b = –0.171, p-val. < 0.01). BAZ did not differ significantly by urban or rural residential location or by region. Interestingly, BAZ in the last three IFLS waves was significantly lower compared to IFLS–2 (1997/1998). Only in IFLS–5 (2014/2015) was the difference in BAZ not significant, although still lower than IFLS–2 (b = –0.034).

When considering the main effects of the women's empowerment indicators, Models 2–4 in Table 2.3 showed that women's empowerment effects on BAZ were absent. Further inclusion of interaction terms between women's empowerment indicators and gender in Models 5–7 unveiled differences in the main effects as well as in the interaction effects for mother's education. Model 6, which had the best fit (lowest AIC=50,452.564), showed that for adolescents who were raised by educated mothers, there was a smaller gender gap for BAZ as boys of educated mothers had a relatively higher BAZ (b = 0.021 per additional year of schooling, p-val. < 0.01).

To make the interaction effect visible, Figure 2.1 depicts the predictive margins for the gendered difference in BAZ by mother's education. The figure showed that the average BAZ for Indonesian adolescent boys and girls was below zero standard deviation (SD) from the mean when compared to the WHO growth reference chart. Figure 2.1 also clearly visualised that on average, boys were thinner than girls. This pattern was most clear for adolescents of mothers with less education years (the mothers have 0 years of schooling: boys = –0.865SD;

girls = –0.458SD). The gender gap in BAZ was smaller for adolescents of educated mothers. However, being raised by an educated mother did not fully compensate adolescent boys' thinness lag (for adolescents whose mothers had at least 12 years of schooling: boys = –0.696SD; girls = –0.549SD). In fact, there was also a slight decrease in BAZ for girls of mothers with more education (Model 6 in Table 2.3: b = –0.008, p-val. < 0.05). There were no gendered differences in BAZ by mother's bargaining power and mother's working status.

Table 2.4 presents food consumption differences between boys and girls by mother's education to understand what sort of food consumption patterns might explain the interaction between mother's education and adolescents' BAZ. For reasons of presentation and to allow t-test analysis, mother's education was collapsed into three categories "never went to school", "1 to 6 years of schooling", and "more than 6 years of schooling". There were clear patterns of gendered food consumption. In general, boys consumed less often vegetables and fast food, but more often instant noodles and soft drinks than girls ("all", p-val. < 0.05). Being raised by a mother with some years of schooling reduced the gender gap in vegetables and fruits consumption as it became non-significant. However, the fast-food consumption of boys whose mother had more than 6 years of schooling increased ("never went to school" = 0.29 days vs "more than 6 years of schooling" = 0.36 days). When comparing between boys and girls of mothers with some years of schooling, the boys' instant noodles consumption was significantly higher than that of girls ("1 to 6 years of schooling": boys = 2.47 days vs girls = 2.21 days, p-val. = 0.03; "more than 6 years of schooling": boys = 2.26 days vs girls = 2.04 days, p-val. = 0.01). The gender gap in instant noodles consumption was not significant for adolescents who were raised by mothers who never went to school (boys = 2.36 days vs girls = 2.21 days, p = 0.38). The t-test for soft drinks consumption of adolescents whose mother had 1 to 6 years of schooling was barely significant (boys = 0.54 days vs girls = 0.42 days, p-val. = 0.06), but the two other categories of mother's education showed significant t-test results. Thus, indicating the gender difference in soft drinks consumption seemed to apply for all adolescents regardless of their mother's education. Overall, boys consumed soft drinks more than the girls ("all": boys = 0.59 days; girls = 0.40 days, p-val. = < 0.01). Although no statistical tests were used to analyse non-gendered patterns of food consumption by mother's education, Table 2.4 indicated that the diets of adolescents whose mothers had more schooling consisted more often of animal-source foods and milk, but less often of vegetables and fruits.

Table 2.2. Multivariate linear regression for HAZ

	model 1	model 2	model 3	model 4	model 5	model 6	model 7
	coef. SE	coef. SE	coef. SE	coef. SE	coef. SE	coef. SE	coef. SE
gender							
girls	ref .	ref .	ref .	ref .	ref .	ref .	ref .
boys	-0.007 (0.015)	-0.009 (0.015)	-0.009 (0.015)	-0.010 (0.015)	-0.025 (0.021)	-0.026 (0.021)	-0.043 (0.029)
women's empowerment							
mother's education		0.009 (0.002)**	0.009 (0.002)**	0.008 (0.002)**	0.007 (0.003)*	0.007 (0.003)*	0.007 (0.003)*
mother's bargaining power			0.000 (0.004)	0.000 (0.004)	0.000 (0.004)	-0.005 (0.006)	-0.004 (0.006)
mother's working status							
did not work				ref .	ref .	ref .	ref .
blue-collar workers				-0.064 (0.023)**	-0.064 (0.023)**	-0.064 (0.023)**	-0.073 (0.029)*
white-collar workers				-0.024 (0.019)	-0.024 (0.019)	-0.024 (0.019)	-0.040 (0.024)
boys × women's empowerment							
mother's education					0.003 (0.003)	0.003 (0.003)	0.003 (0.003)
mother's bargaining power						0.010 (0.008)	0.009 (0.008)
mother's working status							
did not work							ref .
blue-collar workers							0.018 (0.039)
white-collar workers							0.030 (0.033)
control variables:							
mother's height	0.053 (0.002)**	0.053 (0.002)**	0.053 (0.002)**	0.053 (0.002)**	0.053 (0.002)**	0.053 (0.002)**	0.053 (0.002)**
mother's BMI	0.023 (0.002)**	0.022 (0.002)**	0.022 (0.002)**	0.022 (0.002)**	0.022 (0.002)**	0.022 (0.002)**	0.022 (0.002)**
father's height	0.042 (0.002)**	0.042 (0.002)**	0.042 (0.002)**	0.042 (0.002)**	0.042 (0.002)**	0.042 (0.002)**	0.042 (0.002)**
mother's BMI	0.023 (0.003)**	0.022 (0.003)**	0.022 (0.003)**	0.022 (0.003)**	0.022 (0.003)**	0.022 (0.003)**	0.022 (0.003)**
sibling size	-0.068 (0.007)**	-0.068 (0.007)**	-0.068 (0.007)**	-0.069 (0.007)**	-0.069 (0.007)**	-0.069 (0.007)**	-0.069 (0.007)**
PCE (in million Rupiah)	0.036 (0.014)*	0.034 (0.014)*	0.034 (0.014)*	0.034 (0.014)*	0.034 (0.014)*	0.034 (0.014)*	0.034 (0.014)*
adolescents activity							
neither went to school nor work	ref .	ref .	ref .	ref .	ref .	ref .	ref .
went to school only	0.007 (0.026)	-0.007 (0.027)	-0.007 (0.027)	-0.005 (0.027)	-0.004 (0.027)	-0.004 (0.027)	-0.004 (0.027)
went to work only	0.028 (0.031)	0.032 (0.031)	0.032 (0.031)	0.039 (0.031)	0.041 (0.031)	0.040 (0.031)	0.041 (0.031)
went to school and work	0.048 (0.034)	0.039 (0.034)	0.039 (0.034)	0.051 (0.034)	0.052 (0.034)	0.052 (0.034)	0.052 (0.034)
rural	ref .	ref .	ref .	ref .	ref .	ref .	ref .
urban	0.199 (0.018)**	0.189 (0.018)**	0.189 (0.018)**	0.181 (0.018)**	0.180 (0.018)**	0.180 (0.018)**	0.180 (0.018)**
outside Java & Bali	ref .	ref .	ref .	ref .	ref .	ref .	ref .
Java & Bali	0.113 (0.019)**	0.115 (0.019)**	0.115 (0.019)**	0.112 (0.019)**	0.112 (0.019)**	0.112 (0.019)**	0.112 (0.019)**
IFLS 2	ref .	ref .	ref .	ref .	ref .	ref .	ref .
IFLS 3	0.018 (0.018)	0.012 (0.018)	0.012 (0.018)	0.016 (0.018)	0.016 (0.018)	0.016 (0.018)	0.016 (0.018)
IFLS 4	0.073 (0.024)**	0.052 (0.024)*	0.052 (0.024)*	0.062 (0.025)*	0.062 (0.025)*	0.062 (0.025)*	0.062 (0.025)*
IFLS 5	0.176 (0.023)**	0.139 (0.025)**	0.139 (0.025)**	0.148 (0.025)**	0.149 (0.025)**	0.148 (0.025)**	0.148 (0.025)**
constant	-17.666 (0.386)**	-17.544 (0.386)**	-17.544 (0.386)**	-17.455 (0.388)**	-17.447 (0.388)**	-17.446 (0.388)**	-17.437 (0.388)**
R^2	0.263	0.264	0.264	0.265	0.265	0.265	0.265
adj-R^2	0.262	0.263	0.263	0.263	0.263	0.263	0.263
AIC	43,273.099	43,252.180	43,254.178	43,248.204	43,248.791	43,249.093	43,252.201

p-value: *0.05 **0.01
coef. = regression coefficient; SE = standard error; ref. = reference
N observations = 16,683; N adolescents = 13,396; N families = 6,781
birth order dummies were used in the analysis, but not included in the tables to reduce the table size

Table 2.3. Multivariate linear regression for BAZ

	model 1		model 2		model 3		model 4		model 5		model 6		model 7	
	coef.	SE	coef.	SE	coef.	SE	coef.	SE	coef.	SE	coef.	SE	coef.	SE
gender														
girls	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.
boys	-0.313	(0.019)**	-0.314	(0.019)**	-0.314	(0.019)**	-0.313	(0.019)**	-0.406	(0.026)**	-0.404	(0.026)**	-0.394	(0.037)**
women's empowerment														
mother's education			0.003	(0.003)	0.004	(0.003)	0.003	(0.003)	-0.007	(0.003)*	-0.008	(0.003)*	-0.008	(0.004)*
mother's bargaining power					-0.004	(0.005)	-0.005	(0.005)	-0.005	(0.005)	0.003	(0.007)	0.002	(0.007)
mother's working status														
did not work							ref	.	ref	.	ref	.	ref	.
blue-collar workers							0.050	(0.029)	0.050	(0.029)	0.050	(0.029)	0.050	(0.037)
white-collar workers							0.047	(0.024)	0.045	(0.024)	0.045	(0.024)	0.058	(0.031)
boys × women's empowerment														
mother's education									0.021	(0.004)**	0.021	(0.004)**	0.022	(0.004)**
mother's bargaining power											-0.014	(0.010)	-0.013	(0.010)
mother's working status														
did not work													ref	.
blue-collar workers													0.001	(0.049)
white-collar workers													-0.025	(0.042)
control variables:														
mother's height	-0.002	(0.002)	-0.002	(0.002)	-0.002	(0.002)	-0.002	(0.002)	-0.002	(0.002)	-0.002	(0.002)	-0.002	(0.002)
mother's BMI	0.059	(0.003)**	0.059	(0.003)**	0.059	(0.003)**	0.059	(0.003)**	0.059	(0.003)**	0.059	(0.003)**	0.059	(0.003)**
father's height	-0.001	(0.002)	-0.001	(0.002)	-0.001	(0.002)	-0.001	(0.002)	-0.001	(0.002)	-0.001	(0.002)	-0.001	(0.002)
father's BMI	0.073	(0.004)**	0.072	(0.004)**	0.072	(0.004)**	0.072	(0.004)**	0.072	(0.004)**	0.072	(0.004)**	0.072	(0.004)**
sibling size	-0.030	(0.009)**	-0.030	(0.009)**	-0.030	(0.009)**	-0.029	(0.009)**	-0.029	(0.009)**	-0.029	(0.009)**	-0.029	(0.009)**
PCE (in million Rupiah)	0.024	(0.009)*	0.023	(0.009)*	0.023	(0.009)*	0.023	(0.009)*	0.023	(0.009)*	0.023	(0.009)**	0.023	(0.009)*
adolescents activity														
neither went to school nor work	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.
went to school only	-0.283	(0.032)**	-0.288	(0.032)**	-0.288	(0.032)**	-0.291	(0.032)**	-0.286	(0.032)**	-0.286	(0.032)**	-0.286	(0.032)**
went to work only	-0.008	(0.039)	-0.006	(0.039)	-0.006	(0.039)	-0.014	(0.039)	-0.006	(0.039)	-0.005	(0.039)	-0.006	(0.039)
went to school and work	-0.171	(0.041)**	-0.174	(0.042)**	-0.174	(0.042)**	-0.187	(0.042)**	-0.181	(0.042)**	-0.181	(0.042)**	-0.182	(0.042)**
rural	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.
urban	0.007	(0.022)	0.003	(0.022)	0.004	(0.022)	0.009	(0.022)	0.009	(0.022)	0.009	(0.022)	0.009	(0.022)
outside Java & Bali	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.
Java & Bali	-0.002	(0.023)	-0.001	(0.023)	-0.001	(0.023)	-0.001	(0.023)	-0.000	(0.023)	-0.000	(0.023)	-0.000	(0.023)
IFLS 2	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.	ref	.
IFLS 3	-0.102	(0.021)**	-0.104	(0.021)**	-0.104	(0.021)**	-0.108	(0.021)**	-0.108	(0.021)**	-0.108	(0.021)**	-0.108	(0.021)**
IFLS 4	-0.086	(0.027)**	-0.095	(0.028)**	-0.095	(0.028)**	-0.100	(0.028)**	-0.098	(0.028)**	-0.098	(0.028)**	-0.098	(0.028)**
IFLS 5	-0.034	(0.029)	-0.049	(0.031)	-0.048	(0.031)	-0.054	(0.031)	-0.052	(0.031)	-0.052	(0.031)	-0.052	(0.031)
constant	-2.854	(0.430)**	-2.804	(0.429)**	-2.802	(0.429)**	-2.866	(0.433)**	-2.819	(0.433)**	-2.820	(0.433)**	-2.825	(0.433)**
R^2	0.142		0.142		0.142		0.142		0.144		0.144		0.144	
adj-R^2	0.140		0.140		0.140		0.141		0.142		0.142		0.142	
AIC	50,486.455		50,485.943		50,487.257		50,484.769		50,452.789		50,452.564		50,456.023	

p-value: *0.05 **0.01
coef. = regression coefficient; SE = standard error; ref. = reference
N observations = 16,683; N adolescents = 13,396; N families = 6,781
birth order dummies were used in the analysis, but not included in the tables to reduce the table size

Chapter 2

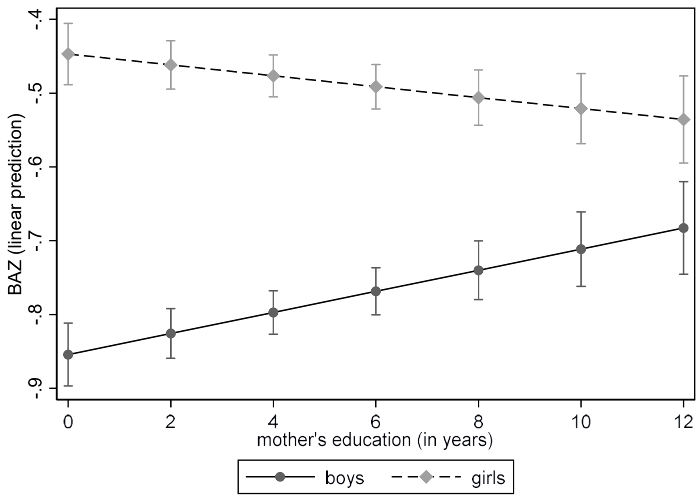

Figure 2.1. BAZ of adolescents by mother's education and gender

Table 2.4. Food consumption t-test by gender and mother's education

food types	mother's education	boys			girls			mean	
		mean	SD	N	mean	SD	N	diff.	p
animal-source food	never went to school	2.35	(1.38)	2,639	2.33	(1.37)	2,614	0.02	0.64
	1 to 6 years of schooling	2.23	(1.32)	1,750	2.21	(1.32)	1,719	0.02	0.72
	more than 6 years of schooling	2.67	(1.33)	2,249	2.64	(1.32)	2,047	0.03	0.46
	all	2.42	(1.36)	6,638	2.40	(1.35)	6,380	0.03	0.24
vegetables	never went to school	3.05	(1.57)	2,639	3.21	(1.58)	2,614	-0.16	0.00
	1 to 6 years of schooling	2.61	(1.67)	1,750	2.70	(1.67)	1,719	-0.09	0.10
	more than 6 years of schooling	2.59	(1.76)	2,249	2.68	(1.76)	2,047	-0.09	0.11
	all	2.78	(1.68)	6,689	2.90	(1.68)	6,436	-0.12	0.00
fruits	never went to school	1.77	(1.46)	2,639	1.84	(1.46)	2,614	-0.08	0.05
	1 to 6 years of schooling	1.42	(1.37)	1,750	1.33	(1.31)	1,719	0.08	0.07
	more than 6 years of schooling	1.10	(1.16)	2,249	1.10	(1.20)	2,047	0.00	0.96
	all	1.45	(1.37)	6,689	1.47	(1.38)	6,436	-0.02	0.51
milk	never went to school	1.18	(2.15)	2,639	1.10	(2.13)	2,614	0.08	0.17
	1 to 6 years of schooling	1.11	(2.05)	1,748	1.09	(2.07)	1,719	0.01	0.85
	more than 6 years of schooling	2.01	(2.67)	2,248	1.99	(2.70)	2,047	0.02	0.77
	all	1.44	(2.35)	6,686	1.37	(2.35)	6,436	0.06	0.13
snacks	never went to school	3.07	(2.22)	377	3.17	(2.14)	346	-0.10	0.53
	1 to 6 years of schooling	3.11	(2.16)	707	3.22	(2.21)	731	-0.11	0.32
	more than 6 years of schooling	3.08	(2.03)	1,227	3.20	(2.02)	1,098	-0.12	0.15
	all	3.08	(2.10)	2,321	3.19	(2.11)	2,186	-0.11	0.07
fast food	never went to school	0.29	(1.03)	377	0.44	(1.34)	346	-0.15	0.09
	1 to 6 years of schooling	0.25	(0.91)	707	0.37	(1.15)	732	-0.12	0.03
	more than 6 years of schooling	0.36	(1.02)	1,227	0.47	(1.15)	1,098	-0.11	0.02
	all	0.31	(0.99)	2,321	0.43	(1.18)	2,187	-0.11	0.00
instant noodles	never went to school	2.36	(2.32)	377	2.21	(2.15)	346	0.15	0.38
	1 to 6 years of schooling	2.47	(2.29)	707	2.21	(2.18)	732	0.26	0.03
	more than 6 years of schooling	2.26	(2.03)	1,227	2.04	(1.95)	1,098	0.21	0.01
	all	2.35	(2.17)	2,321	2.12	(2.06)	2,187	0.22	0.00
soft drinks	never went to school	0.69	(1.35)	376	0.42	(1.17)	346	0.27	0.00
	1 to 6 years of schooling	0.54	(1.28)	708	0.42	(1.16)	732	0.12	0.06
	more than 6 years of schooling	0.60	(1.19)	1,227	0.38	(1.02)	1,098	0.22	0.00
	all	0.60	(1.24)	2,321	0.40	(1.09)	2,187	0.19	0.00

SD = standard deviation; mean diff. = mean differences of boys vs girls; p = p-value

2.7 Discussion

The authors have examined the two proposed hypotheses using a set of multivariate linear regression models. Furthermore, to understand the underlying causes of the interaction between mother's education and gendered BAZ, the authors have also conducted t-test analyses. Since the results showed that the effects of women's empowerment on adolescent nutritional status were mixed, the authors suggested Hypothesis I was confirmed to some extent. While being raised by educated mothers positively correlated with adolescents' HAZ, having a mother who had a blue-collar job was found to be associated with shorter height. There were no significant effects of mother's bargaining power on adolescent nutritional status in terms of both HAZ and BAZ. This study found interesting evidence on gender inequalities in adolescent nutritional status. Similar to patterns of undernourished adolescent boys in the WHO summary report on certain Asian societies (WHO 2006a), the results of this study indicated that Indonesian adolescent boys were on average thinner, i.e., had a lower BAZ, than girls. This study also showed a significant interaction between gender and mother's education in terms of BAZ. Being raised by a mother who spent more years in school reduced the gap between boys and girls by increasing BAZ for adolescent boys. Therefore, the gender gap in BAZ was smaller for adolescents of educated mothers. This firmly confirmed Hypothesis II. Further analyses unveiled gendered patterns of food consumption by mother's education. Despite the fact that adolescents of mothers who had some years of schooling consumed less vegetables and fruits than those whose mothers had never been to school; their gender gap in BAZ was actually smaller due to boys' consuming more fast food and having higher instant noodles consumption than the girls.

This study showed that different indicators of women's empowerment influenced adolescent nutritional status in different ways. Mother's education was strongly linked to positive outcomes and more gender equality in nutritional status during adolescence. This evidence justifies investment in girls' education since such investment may not only benefit her future labour market chances but may also lead to positive outcomes for the health and nutritional status of her future children. However, the negative association between mothers' working status, particularly those who had a blue-collar job, and adolescents' HAZ should also be a concern. The authors were unable to examine the underlying causes for this negative association thoroughly. However, a blue-collar job is often associated with low socioeconomic status (SES) as well as in most cases, long and less flexible working hours. Combinations of these two factors might leave blue-collar mothers with scarce financial and likely, time resources to supervise the eating patterns of their adolescent children similar to what has been found in studies of children under-five (Roshita et al. 2013; Toyama et al. 2001). The extensive consumption of fast food and instant noodles among Indonesian adolescents that the authors found is similar to Baker & Friel (2014)'s study on the rise of processed foods consumption and the nutrition transition in Asia. However, different to Baker & Friel (2014), this study unveiled gender differences in the consumption of what many have considered to be unhealthy calorie-rich types of foods.

The positive association that this study found between mother's education and HAZ replicates the same association as reported in studies on child nutrition (Semba et al. 2008; Skoufias 1999; Thomas et al. 1991). Given that this study analysed the adolescent life stage, this finding indicates that the link between mother's education and HAZ in childhood may extend into adolescence. Different to a study by Thomas et al. (2002), who found that mother's bargaining power affected child's health, this study did not find any evidence linking the mother's bargaining power and nutritional status. One probable explanation for this non-significant association might be due to the difference in how the bargaining power indicator was constructed. The indicator for mother's bargaining power in this study was derived from questions on household decision-making instead of from the pre-marital resources that Thomas et al. (2002) used. Considering that most Indonesian mothers had a fairly high authority in domestic matters, variability in mother's bargaining power may not be sufficient to show the effect of mother's bargaining power on adolescent nutritional status. Similar to the possible detrimental effect of the mother's working status that has been reported by Cunningham et al. (2015), this study observed negative results where the linkage between mother's working status and adolescent nutritional status is concerned. However, this study added more clarity and detailed information by showing that significant negative effects occurred only for HAZ and only for adolescents whose mothers were blue-collar workers. This study also showed that gender inequality in BAZ is smaller for adolescents of educated mothers. This result is similar to research in India by Bose (2011), who reported that being raised by a more empowered mother reduced gender gaps in nutrition for under-five children. However, in contrast to Bose's study in which the empowered mothers benefit their undernourished daughters by allocating a protein rich diet, the authors found some indication that the smaller gender gap in BAZ in this study might be due to the unhealthy calorie-rich diet consisting of more fast food and instant noodles among boys of educated mothers.

The study also had some limitations. First, observations from all IFLS waves were merged to construct the analytical sample. While this approach increased the statistical power of the analyses, it restricts the authors in being able to ascertain whether the effect of women's empowerment on adolescents' nutritional status was a true causal effect or simply a correlation. Future research should consider more rigorous methods which take, for example, time-lags into account to be able to establish causal effects of women's empowerment on adolescent nutritional status with more certainty. A second important limitation is that previous studies have proposed that the effect of women's empowerment on child health might be overstated because of certain indicators of women's empowerment, particularly the mother's education, correlate with the family's socioeconomic status (SES) (Parashar 2005). In this regard, SES might confound the positive linkage between women's empowerment and nutritional status of her children. Although this study has controlled for family SES by including PCE, some bias might remain. Therefore, interpretation of women's empowerment effects on adolescent nutritional status should be interpreted with caution. The results of this study show that different indicators of women's empowerment may affect adolescents' nutritional status differently. However, since indicators of women's empowerment are multidimensional, researchers may consider a broader set of indicators for future research. The mother's social capital is an example of a women's empowerment indicator which was not analysed in this study but has previously shown to be an important channel through which the mother could improve her knowledge on nutrition and health behaviour (Sujarwoto & Tampubolon 2013; De Silva & Harpham 2007). This study focused on anthropometric indicators of adolescent nutritional status. Future research might also examine other indicators such as haemoglobin level to have a better understanding of nutritional status dynamics during adolescence. The food consumption analyses that this study used were still very exploratory and could be advanced further by taking actual food consumption patterns into account. The food consumption analyses could also be improved using multivariate setups and controls for confounders related to food consumption patterns such as food availability (Hillbruner & Egan 2008), food price (Beydoun et al. 2008; Grossman et al. 2014), and awareness of what a healthy diet is (Datar et al. 2014). This study concentrated on undernutrition which is not the sole malnutrition problem in Indonesia. The double burden of malnutrition among adults is also reported in a recent study in Indonesia and may took place in adolescence as well (Hanandita & Tampubolon 2015). Therefore, it is interesting for future research to examine to what extent women's empowerment could prevent particularly more affluent Indonesian groups from malnutrition due to obesity. Another suggestion for future research is to examine via what arrangements the negative effects on HAZ, which occurred among adolescents of blue-collar mothers, could be overcome.

In conclusion, this study showed that women's empowerment, particularly the mother's education, positively affects adolescent nutritional status. The study also indicated smaller gender gaps in nutritional status for adolescents who were raised by educated mothers. This finding may justify more investment in girls' education to benefit the future generation not only during childhood, but such investments may well extend into adolescence. However, caution should be exercised since the smaller gender gap was possibly a result of unhealthy weight gain of adolescent boys of more educated mothers. Therefore, besides the focus on girls, helping boys in adopting a healthy diet should be on the agenda of scholars and policymakers to improve adolescent boys' nutrition as well as to reduce the gender gap in adolescent nutritional status.

Chapter 3

Sibling inequalities in overweight and the role of mother's education

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Abstract

Background: Previous studies have shown that sibling inequalities in overweight vary across contexts. Furthermore, research on the extent to which parental factors such as mother's education can compensate for or reinforce such disparities is considerably rare.

Objective: This study analyses to what extent, and how, the chances of overweight among children (0–19 years of age) vary systematically by gender, birth order, and number of siblings. We also look at whether mother's education buffers or aggravates sibling inequalities in overweight.

Methods: Data were from the fifth wave of the Indonesian Family Life Survey (IFLS–5) 2014/2015, which comprised 6723 children born in 4784 families. We applied within-family centred birth order dummies to disentangle the effects of birth order from those of number of siblings. Cluster-robust logistic regressions were conducted.

Results: Overweight occurred more in eldest and youngest children, and in children of smaller families. Mother's education amplified sibling inequalities. Odds of overweight in children increased along with increased years of mothers' education. This was greater for boys and eldest children. Further analyses indicated that boys whose mothers spent more years in school consumed high-calorie foods more often.

Conclusion: The overall results indicate that mother's education aggravates sibling inequalities in overweight. Nutrition interventions to reduce overweight in children should target the eldest and the youngest children, and children of smaller families. Mothers who had more school years, and particularly their sons, should also be in the target group. Lastly, boys should be advised to consume high-calorie foods less often.

3.1 Introduction

Overweight compromises human capital accumulation and increases the risks of non-communicable diseases (NCDs) over the life course. Schwimmer et al. (2003) found that being overweight in childhood and adolescence reduced functioning in the physical, emotional, social, and school domains. These may result in lower skill attainment that likely limits individual contributions to the economy later in life (Murasko 2015; Palermo & Dowd 2012; Sargent & Blanchflower 1994). Overweight children might also experience a lower quality of life in adulthood because of cardiovascular diseases, diabetes, and certain types of cancer (Reilly & Kelly 2010). This evidence underlines how critical it is to understand and address the causes of overweight before children enter adulthood.

So far, most scientific debates on risk factors of overweight have revolved around socioeconomic status (SES) and spatial location (urban vs rural) (Aizawa & Helbe 2017; Drewnowski & Specter 2004; Baker et al. 2006; Davis & Carpenter 2009). This study, however, takes a different approach, by diving deeper into the household, examining sibling inequalities in overweight and the role of mother's education therein. Previous studies have shown that overweight in children differs by gender, birth order, and number of siblings. (R. H. Mosli et al. 2015; Ochiai et al. 2012; Madden 2017; R.H. Mosli et al. 2015; Hu et al. 2017). However, results indicating which children in the sibling set (e.g., the eldest, youngest etc.) have higher odds of overweight diverge across contexts. Contradictory results are found both in developed and developing countries, and with respect to different population subgroups (Meller et al. 2018). Hence, it is unclear what mechanisms explain sibling inequalities in overweight under what particular circumstances. Moreover, in contrast to the literature on undernutrition, i.e., stunting and wasting, in which the role of mother's education in improving children's nutritional status has received ample attention (Kunto & Bras 2018; Abuya et al. 2012), there has been hardly any research about the association between mother's education, sibling differences, and the risk of overweight in children, particularly in developing countries.

This study contributes to the growing literature on child obesity in three ways. First, we examine not only how gender, birth order, and the number of siblings affect overweight during childhood and adolescence, but also whether mother's education plays a role in these inequalities. Second, we investigate the moderating effects of mother's education on sibling inequalities in overweight. Third, we test whether the role of mother's education in adjusting the risk factors of overweight might overlap with the effects of SES. This is in response to critics that the effects of mother's education on children's nutritional status could be spurious, because mothers who had more school years are usually from high SES families (Parashar 2005; Desai & Alva 1998).

Our study uses data from the fifth wave of the Indonesian Family Life Survey (IFLS) 2014/2015, which comprised 6723 children (0–19 years of age) born in 4784 families. Aside from multiple health indicators, IFLS also collected SES-related information (Strauss, Witoelar, Sikoki, et al. 2016), which enables controlling for potential confounders of health outcomes. Since IFLS is a household survey, it is possible to construct an analytical sample of household data that links the mother, children and siblings. The IFLS–5 (2014/2015) introduced a new food consumption module, which collected data on the consumption of high-calorie foods by household members (Strauss, Witoelar & Sikoki 2016). This unlocked possibilities to examine overconsumption of high-calorie foods as a potential channel through which children may develop overweight.

The Indonesian context enhances this study's societal relevance since, with more than 250 million inhabitants, Indonesia is the world's fourth largest country. Furthermore, Indonesia's emerging economy has experienced vast economic growth. The Gross National Income (GNI) per capita has grown six-fold from US$ 580 in 2000 to US$ 3540 in 2017 (World Bank 2019). This has increased the purchasing power of Indonesian families. In 2017, spending on prepared food and beverages counted for 17.2 % of the total monthly average per capita expenditure, which is nearly twice the percentage (9.5%) in 1999 (Statistics Indonesia 2018). It has been estimated that 5.9 million Indonesian boys (16.7%) and 4.8 million girls aged 5 to 19 years (14.4%) were either overweight or obese in 2016, which jointly nearly triples the 2010 figure (NCD-RisC 2017; Statistics Indonesia 2013). This suggests that Indonesia is in the fourth stage of the global nutrition transition, which is marked by a change towards high-calorie diets (i.e., high total fat, high sugar, and processed foods) and an increasing risk of overweight.

3.2 Background and Hypotheses

The global nutrition transition framework of Popkin (1993) and Popkin et al. (2012) aims to understand how overweight may develop into a global threat to the health of populations. It describes five stages of shifting trends in nutrition and lifestyle, starting from: (1) hunter-gatherers: varied diet, physically active lifestyle; to (2) famine: less varied diet, agricultural settlement; (3) receding famine: less varied diet continued, industrial revolution; (4) the emergence of non-communicable diseases (NCDs): increasing consumption of high-calorie foods, physically a less active lifestyle; and lastly (5) behavioural changes: increasing public awareness of healthy diets and lifestyle. Most of today's populations are in one of the last three stages. In the third stage of receding famine, economic conditions have improved and families have become more food secure, and thus are less likely to be undernourished. At the same time, economic change and the introduction of new technologies have reduced physical activity. Furthermore, globally, a diet that is high in saturated fat, sugar, and refined foods (often low in fibre) is gaining ground (Popkin 1993). The fourth stage is characterised by the rise of overweight, due to the combination of overconsumption of high-calorie foods and a sedentary lifestyle, resulting in an energy imbalance. This may induce NCDs and premature mortality (NCD-RisC 2017; Reilly & Kelly 2010). At the fifth stage, public awareness propels behavioural changes that result in healthier diets and a physically active lifestyle.

Although useful, the global nutrition transition framework is a macro-level framework (Hawkes 2006; Lang & Rayner 2007), which renders many micro-level aspects of overweight invisible. These aspects include sibling inequalities (i.e., differences by gender, birth order, and number of siblings). To investigate these aspects further, we used resource dilution theory as our point of departure. This theory has been used to explain intra-household inequalities in life course outcomes with regard to sibling dynamics in various settings (Downey 2001). It is based on the assumption that family resources are finite and that the more children there are in a family, the smaller the share of family resources available per child. Children with many siblings usually have, for example, a lower educational attainment (Bras et al. 2010; Booth & Kee 2009) and a lower nutritional status than children with fewer siblings (Jayachandran & Pande 2017). Interestingly, in relation to overweight, having more siblings can be positive. Smaller food shares and more physical activity, i.e., via group play, may help children to balance their energy levels, and could prevent them from being overweight (Hallal et al. 2006).

Most studies based on resource dilution theory start with the hypothesis that the allocation of family resources diminishes with higher birth order. This might not necessarily apply to overweight in children. The "neglected middle-child" hypothesis that is popular in psychology, for example, suggests that parents, because of diverse reasons, give attention and family resources to the eldest and the youngest child more than to the middle-child (Conley 1983; Conley 2005). As shown by Ochiai et al. (2012), this hypothesis may also apply to overweight in children. They found that among Japanese school-aged children, the eldest and the youngest are at higher odds of being overweight than middle-children. In contrast, in a study in a low-income community in the United States (US), only the youngest had higher risks of being overweight (R. H. Mosli et al. 2015). It was suggested that this resulted from food resources benefitting the youngest, while elder siblings were often working and had a higher energy expenditure. These examples show the mixed evidence on birth order effects on overweight in children and their differences across contexts (Meller et al. 2018).

Family resources might also be distributed unequally among sons and daughters. Discrimination in food allocation against girls places them at a risk of low nutritional status, particularly in societies with a patrilineal and patrilocal tradition (Madjdian & Bras 2016; Jayachandran & Pande 2017). However, modernisation of norms and values may shift the situation for the benefit of girls. In Indonesia, for example, the growing economy and the existence of egalitarian gender norms induce equal food access for girls and boys (Kunto & Bras 2019). Related to overweight, globally the norm for girls that 'being slim is being beautiful' is gaining ground (Arimbi 2011), which could motivate girls and their parents to adjust girls' diets in order to comply with the norm. On the other hand, the lack of a similar norm for boys leaves them more vulnerable to overconsumption of foods, resulting in a higher risk of overweight.

The role of the mother on her children's life outcomes is critical. A study by LaFave & Thomas (2014) in Indonesia, for example, strongly suggests that mother's influence on child's health, e.g., nutritional status and cognitive capacity, was significantly greater than that of the father and extended family members, including grandparents. In the context of Indonesia, the greater influence of the mothers was perhaps due to the family planning programme under The New Order Regime (1968–1998). The programme has transformed the society to be more conjugal in family structure, reducing that of the influence of extended family members. Furthermore, within the programme, there was also a "social engineering" to place the mother as a nurturer and more as the primary caregiver for children (Niehof & Lubis 2003).

A number of studies have suggested that mothers who spent more years in school often have more opportunities than fathers to practice their agency in managing family resources to benefit their children (Smith & Haddad 2000; Smith et al. 2003; Burroway 2016; Sen 2009). This can be indirect, through expansion of her chance to participate in the labour market and earn money in order to provide more food security to her children (Sen 2009). Another channel is more direct and relates to the educated mother's ability to access and use nutrition information (Burroway 2016). It suggests that mothers who had more school years are more open to new diets and nutrition innovations which may improve the nutritional status of their children (Smith & Haddad 2000). Studies in developed countries seem to confirm that and show that children of educated mothers—mothers who had more school years—are less often overweight (Madden 2017; Ruiz et al. 2016; Apouey & Geoffard 2016). The relation may however be different in the developing world. A small-scale study in Bogor–Indonesia found that children of educated mothers were more susceptible to overweight (Ekawidyani et al. 2018). The study found that these children received more pocket money, which was mostly spent on high-calorie foods at school.

Whereas the role of mother's education in compensating or aggravating inequalities in overweight by birth order and the number of siblings is under-studied, the positive role of mother's education in reducing gender inequality in undernutrition is well documented (Bose 2011; Haddad 1999). However, this should be interpreted cautiously; Kunto & Bras (2018) found evidence that, in Indonesia, the more years of formal education the mothers had would compensate for boys' deficit in body mass, but in unhealthy ways. This was done most likely by unintentionally allowing boys to consume high-calorie foods more often.

Informed by the studies reviewed above, we formulated two hypotheses. First, sibling inequalities (i.e., in terms of gender, birth order, and number of siblings) and mother's education influence overweight in children (H1). While the effects of birth order may vary, boys together with children of smaller families are expected to be more at risk of overweight, irrespective of mother's education. Second, mother's education plays a moderating role in sibling inequalities in overweight (H2). We expect these moderating effects of mother's education to apply at least to gender. We hypothesise that boys whose mothers spent more years in school consumed high-calorie foods more often than girls and, thereby, are more likely to be overweight.

3.3 Methods

We derived our data from the Indonesian Family Life Survey (IFLS), the largest ongoing household panel survey, which collects multiple indicators of socioeconomic and health information in Indonesia. The first wave of IFLS was in 1993/1994 and, since then, four follow-up surveys have been carried out in 1997/1998, 2000, 2007/2008, and 2014/2015. Details of the IFLS can be found in Strauss, Witoelar & Sikoki (2016).

Analytical sample

In order to produce a recent picture of overweight among Indonesian children, we based this study on the latest wave, IFLS–5 (2014/2015). The fifth IFLS featured improvements to previous waves by including more health and psychological indicators, among other elements, and, importantly for this study, data on the weekly consumption frequency of high-calorie foods. New data on the consumption of high-calorie foods enable us to examine the overconsumption of high-calorie foods as a channel through which children might develop overweight. Our analytical sample consisted of 6723 children (0–19 years of age) born in 4784 families.

Outcome variables

Two outcome variables were developed: “overweight” as the main outcome variable and “consumption of high-calorie foods” as a secondary outcome variable. We used the latter variable to analyse sibling inequalities and the role of mother’s education in regulating overconsumption of high-calorie foods.

We assigned a dummy variable to record overweight (0 = non-overweight, 1 = overweight). In IFLS, trained nurses used calibrated tools to collect data on height and weight of all present household members. We used these data to evaluate overweight in children (0–19 years of age). As children are still growing and have not yet attained their final stature, measuring overweight in children differs from that of adults. Instead of using the Body Mass Index (BMI), which is commonly used to evaluate adult overweight, we used the World Health Organization (WHO) BMI-for-age Z-scores (BAZ). The BAZ are standardised BMI by sex and age (de Onis et al. 2007; de Onis 2007). We are aware that WHO recommends weight-for-length Z-scores (WLZ) to evaluate healthy weight of under-five children. However, a recent article found that, even for children of this age, BAZ perform similar to, if not better than, WAZ in identifying overweight children (Roy et al. 2016). We therefore used BAZ for all children in our sample (0–19 years of age). A cut-off value ≥ 1 SD (standard deviation) for BAZ was used to classify children into “overweight” (de Onis et al. 2007; de Onis 2007). Since those who were obese (BAZ ≥ 2 SD) only constituted a small percentage, we classified them as overweight children. This simplified the analyses and ensured that this study had sufficient statistical power to test the hypotheses.

IFLS–5 (2014/2015) surveyed the weekly consumption of 17 food items (Strauss, Witoelar & Sikoki 2016). Five of these can be classified as high-calorie foods: instant noodles, fast foods, carbonated beverages, fried snacks, and sweet snacks. Each household member was asked how many days during the week prior to the interview (s)he consumed a specific food item. The mother was usually the person who answered these questions for children under the age of 11 (Strauss, Witoelar, Sikoki, et al. 2016). We computed “consumption of high-calorie foods” as the sum of weekly consumption frequency of the five high-calorie foods, which yielded a scoring range of 0–35. This score provides only a qualitative assessment of intake because it does not assess the portion and the exact nutrients the foods consisted of. Therefore, any analytical result of this variable should be interpreted carefully. Only scores for children aged 2–19 were computed, because of the different feeding patterns of children under the age of two.

Explanatory variables

Four explanatory variables were used: "sex", "birth order," "number of siblings," and "mother's education." We used sex as a dummy variable for gender (0 = girls, 1 = boys). Recent studies on overweight in children indicate that the effects of birth order on overweight are most likely non-linear (R. H. Mosli et al. 2015; Ochiai et al. 2012; R.H. Mosli et al. 2015; Meller et al. 2018). Hence, we grouped children who currently lived in the household into three categories: eldest, mid-child, and youngest. Unfortunately, assigning these types of birth order dummies cannot convincingly disentangle the effects of birth order from that of number of siblings (Booth & Kee 2009). Therefore, we applied within-family centred birth order dummies to better address the problem. The transformation process is as follows:

Suppose n_i is "number of siblings" for child i and d_{im} is the birth order dummy for child i born to family m; we computed the within-family mean of each birth order dummy $\bar{d}_i = 1/n_i \times \sum d_{im}$. We then subtracted $\bar{d}_i$ from d_{im}, such that the within-family centred birth order dummy became $d^*_{im} = d_{im} - \bar{d}_i$. We did the transformation for all three birth order dummies. For families with an "only child" or without a sibling, the three transformed birth order dummies are null. In families with two children, only the transformed mid-child dummy is null. The approach therefore emulates within-family fixed effects (Allison 2009), but without the need to exclude families with two children or less. It also avoids assigning "only child" as "eldest", which was problematic in previous studies (Meller et al. 2018).

"Mother's education" is measured by the number of years the mother spent in school at the time of interview. This could take a value of between 0 years (never went to school) to 12 years (of at least high school graduate). We assigned 12 years of education for mothers who had some years of tertiary education or hold a degree. In the multivariate analyses, we centred mother's education between families to better guide the interpretations and to reduce multicollinearity, particularly with number of siblings.

Control variables

We followed previous studies in including "child's age" (in years), "birth weight" (5 groups: < 2.5 kg, 2.5–< 3 kg, 3–< 3.5 kg, 3.5–< 4 kg, ≥ 4 kg) and "maternal overweight" (0 if BMI < 25, 1 if BMI ≥ 25) as control variables (Ochiai et al. 2012; Xu et al. 2011; Danielzik et al. 2004).

Birth weight needs to be included to control for prenatal biological factors (e.g. maternal weight at time of gestation and weight gain during gestation) that might confound the risk of overweight in children. We further used quintile dummies of nominal Personal Consumption Expenditure (PCE) to control for confounding effects of household Socioeconomic Status (SES) on overweight in children. The procedure to develop PCE for these SES dummies was taken from Witoelar (2009). In addition, we included residential area of urban vs rural and also, Java-Bali vs outside Java-Bali. Java-Bali areas are more developed than other areas in Indonesia. Lastly, we included month of interview (bi-monthly fixed-effects). These last two control variables were used to control for unobserved spatial (residential area) and temporal effects (bi-monthly fixed-effects) of nutrient intake and energy expenditure.

Analyses

The analyses were structured in four steps. We started with Model 1, which is a basic logistic regression model analysing the main effects of the explanatory variables on overweight. Model 1 tested sibling inequalities and the direct effects of mother's education on overweight (H1). A simplified notation for Model 1 is as follows:

$$logit(p_{im}) = \beta_0 + \beta_1\, sex_{im} + \beta_2\, border_{im} + \beta_3\, nsib_m + \beta_4\, medu_m + \beta_5\, X_{im} + \varepsilon_{im} \qquad (1)$$

where $logit(p_{im})$ is the logit function of overweight for child i born in family m, sex_{im} is gender dummy, $border_{im}$ are within-family centred birth order dummies, $nsib_m$ is the number of siblings, $medu_m$ is mother's education, X_{im} is a vector of control variables, and the residuals ε_{im}.

In the following Models 2–4, we sequentially added interactions of mother's education with gender, birth order, and number of siblings. Models 2–4 tested the role of mother's education in explaining sibling differences in overweight (H2). The models tested whether there were different effects of gender, birth order, and number of siblings on overweight according to maternal education. These 'moderating effects analyses' thus evaluated whether more years spent in school by mothers buffered, aggravated or did not change the effect of gender, birth order, and number of siblings on overweight.

$$logit(p_{im}) = \beta_0 + \beta_1\, sex_{im} + \beta_2\, border_{im} + \beta_3\, nsib_m + \beta_4\, medu_m + \beta_5\, (sex_{im} \times medu_m) + \beta_6\, X_{im} + \varepsilon_{im} \qquad (2)$$

$$logit(p_{im}) = \beta_0 + \beta_1\, sex_{im} + \beta_2\, border_{im} + \beta_3\, nsib_m + \beta_4\, medu_m + \beta_5\, (sex_{im} \times medu_m) + \beta_6\, (border_{im} \times medu_m) + \beta_7\, X_{im} + \varepsilon_{im} \quad (3)$$

$$logit(p_{im}) = \beta_0 + \beta_1\, sex_{im} + \beta_2\, border_{im} + \beta_3\, nsib_m + \beta_4\, medu_m + \beta_5\, (sex_{im} \times medu_m) + \beta_6\, (border_{im} \times medu_m) + \beta_7\, (nsib_m \times medu_m) + \beta_8\, X_{im} + \varepsilon_{im} \quad (4)$$

We considered a model among Models 1–4 as parsimonious, if the model had the lowest AIC (Akaike Information Criterion), while retaining the smallest number of parameters (Fabozzi et al. 2014). We added two additional analyses. The first is to analyse the role of mother's education in differing consumption of high-calorie foods within siblings, while the second is to compare moderating effects of mother's education to those of SES on sibling inequalities in overweight. Results for these two analyses were based on the most parsimonious models of Models 1–4.

In the first set of the additional analyses, we examined sibling inequalities and the role of mother's education in the consumption of high-calorie foods. We carried out the analyses by substituting the dependent variable of the most parsimonious model with the consumption of high-calorie foods score. We used multivariate linear regressions for these analyses.

The second set of additional analyses were carried out to settle concerns that the effects of mother's education on children's nutritional status could be spurious (Parashar 2005; Desai & Alva 1998). This is because mothers who had more years in school are mostly from high SES families. The concerns can be difficult to test in setups where mother's education and SES are only placed as main effects. However, as shown in Models 2–4, our foremost interest was in the moderating effects of mother's education. Therefore, by substituting interactions of mother's education with SES, we could evaluate if the moderating effects of mother's education differed from those of SES. We used two specifications of SES for this second additional analysis: linear specification of SES and *ln*(PCE).

All multivariate analyses that we applied used cluster-robust standard errors at the family level. This is to correct for estimation bias, due to clustering involving within-family unobserved correlations.

3.4 Results

Table 3.1 presents bivariate analyses of children's characteristics and overweight. The results indicate that the proportion of boys in the "overweight" group was significantly higher than that of girls (odds of boys vs girls: 0.19 vs 0.17). There were also significant differences between the "non-overweight" and the "overweight" groups in terms of birth order, child's age, and birth weight. Compared to being a middle child, being the eldest or the youngest was associated with higher odds of overweight (odds of eldest vs mid-child vs youngest: 0.18 vs 0.12 vs 0.20). As indicated by the mean age, younger children were more likely to be overweight than older children. This can be interpreted in two ways. First, children were less likely to be overweight when they grew up (age effects) and second, children of the younger cohorts, for any cohort-related reason (i.e., greater adherence to high-calorie diets, and being less physically active), had higher odds of being overweight than children from older cohorts (cohort effects). Table 3.1 suggests that heavier babies have increasing odds of being overweight as a child (e.g., <2.5 kg vs ≥4kg: 0.14 vs 0.24). This evidence concurs with other studies, which found a positive link between birth weight and overweight in children (Danielzik et al. 2004).

Table 3.1. Bivariate analyses of children's characteristics and overweight

	non-overweight (N=5696)	n(%)	overweight (N=1027)	n(%)	odds[a]	p-val.[b]
sex						
Boys	2847	(49.9)	550	(53.5)	0.19	0.035
Girls	2849	(50.1)	477	(46.5)	0.17	
birth order						
eldest	3100	(54.5)	562	(54.8)	0.18	0.001
mid-child	605	(10.6)	71	(6.9)	0.12	
youngest	1991	(34.9)	394	(38.3)	0.20	
age[c]	8.0	(5.12)	7.4	(5.09)		0.001
birth weight						
<2.5 kg	461	(8.1)	62	(6.0)	0.13	<0.001
2.5–<3 kg	1335	(23.5)	203	(19.8)	0.15	
3–<3.5 kg	2360	(41.5)	423	(41.1)	0.18	
3.5–<4 kg	1155	(20.2)	247	(24.1)	0.21	
>=4 kg	385	(6.7)	92	(9.0)	0.24	
consumption of high-calorie[c, d]	9.8	(5.39)	9.9	(5.31)		0.667

[a] odds of overweight for each category: odds = N overweight / N non-overweight.
[b] χ^2-test for categorical variables or t-test for continuous variables.
[c] mean with SD in parentheses.
[d] children older than 2 years of age, N non-overweight=4996, N overweight=847

Table 3.1 shows that there was no significant difference in the consumption of high-calorie foods between the "non-overweight" and the "overweight" groups (*p*-val. = 0.667). A reverse causality might disguise the expected link between consumption of high-calorie foods and overweight. Perhaps overweight children reduce how often they consume high-calorie foods, including the portion, in order to manage their weight. The empirical verification of this reverse causality requires future study. For the current study, we assume that consuming high-calorie foods increases the odds of overweight.

Table 3.2. Bivariate analyses of family characteristics and overweight

	non-overweight (N=5696)	n(%)	overweight (N=1027)	n(%)	odds[a]	p-val.[b]
number of siblings[c]	2.1	(0.01)	2.0	(0.03)		0.002
sibling size						
one (only child)	1617	(28.4)	322	(31.4)		0.049
two	2561	(44.9)	464	(45.2)		
three or more	1518	(26.7)	241	(23.5)		
mother's education (years)[c]	8.8	(3.22)	9.5	(3.16)		<0.001
matenal overweight						
no	3177	(55.9)	445	(43.4)	0.14	<0.001
yes	2504	(44.1)	581	(56.6)	0.23	
SES dummies						
Q1	1460	(25.7)	206	(20.1)	0.14	<0.001
Q2	1414	(24.9)	204	(19.9)	0.14	
Q3	1270	(22.4)	216	(21.1)	0.17	
Q4	1060	(18.7)	209	(20.4)	0.20	
Q5	477	(8.4)	191	(18.6)	0.40	
ln(PCE)	13.6	(0.56)	13.7	(0.64)		<0.001
residential area						
urban	3493	(61.5)	722	(70.4)	0.21	<0.001
rural	2188	(38.5)	304	(29.6)	0.14	
Java-Bali	4155	(73.1)	815	(79.4)	0.20	<0.001
Outside Java-Bali	1526	(26.9)	211	(20.6)	0.14	
month of interview						
Jan–Feb	1366	(24.1)	240	(23.4)	0.18	<0.001
Mar–Apr	890	(15.7)	200	(19.5)	0.22	
Mei–Jun	497	(8.8)	122	(11.9)	0.25	
Jul–Aug	257	(4.5)	74	(7.2)	0.29	
Sep–Oct	1030	(18.1)	153	(14.9)	0.15	
Nov–Dec	1641	(28.9)	237	(23.1)	0.14	

[a] odds of overweight for each category: odds = N overweight / N non-overweight.
[b] χ^2-test for categorical variables or t-test for continuous variables.
[c] mean with SD in parentheses.

Table 3.2 shows bivariate analyses of family characteristics and overweight. The table suggests that those who had fewer siblings, were children of mothers with more school years, and were children whose mother was overweight—a proxy for the unhealthy lifestyle of the mother—were more often found to be overweight. This also applied for children of higher SES families (e.g. odds Q1 vs Q5: 0.14 vs 0.40). The results also reveal that those who lived in rural areas or in less developed areas outside Java-Bali were less likely to be overweight. Perhaps the manual labour activities that characterise life in these areas require high energy expenditure by its inhabitants, including children. The regions outside Java-Bali are largely remote, meaning that market infiltration of high-calorie foods is probably less intense. More overweight children were found in the March to August interviews. This could be an indication of seasonal effects on overweight. Future studies have to fully uncover such seasonal effects, because the data that this study used is cross-sectional data from a single IFLS wave.

Table 3.3. Main effects and moderating effects of explanatory variables on overweight

	Model 1	Model 2	Model 3	Model 4
	AOR SE	AOR SE	AOR SE	AOR SE
interaction effects:				
sex × mother's education[b]				
girls		1.000 (.)	1.000 (.)	1.000 (.)
boys		1.052 (0.026)*	1.053 (0.026)*	1.052 (0.025)*
birth order[a] × mother's education[b]				
eldest			1.161 (0.071)*	1.162 (0.068)**
middle			1.000 (.)	1.000 (.)
youngest			1.045 (0.058)	1.053 (0.055)
number of siblings × mother's education[b]				0.981 (0.014)
main effects:				
sex				
girls	1.000 (.)	1.000 (.)	1.000 (.)	1.000 (.)
boys	1.125 (0.079)	1.095 (0.079)	1.089 (0.078)	1.093 (0.078)
birth order[a]				
eldest	1.420 (0.232)*	1.419 (0.234)*	1.280 (0.219)	1.300 (0.220)
middle	1.000 (.)	1.000 (.)	1.000 (.)	1.000 (.)
youngest	1.560 (0.245)**	1.565 (0.245)**	1.533 (0.242)**	1.548 (0.241)**
number of siblings	0.888 (0.039)**	0.887 (0.039)**	0.881 (0.039)**	0.884 (0.039)**
mother's education[b]	1.033 (0.014)*	1.007 (0.018)	1.018 (0.019)	1.058 (0.035)
control variables included?	yes	yes	yes	yes
N of children	6723	6723	6723	6723
N of families	4784	4784	4784	4784
Pseudo-R^2	0.048	0.049	0.052	0.052
AIC	5516.942	5513.932	5504.549	5504.113

** p-val.< 0.05, * p-val. < 0.01
[a] within-family centred birth order dummies.
[b] between-families centred mother's education.
AORs are odds ratio adjusted for control variables: child's age, birth weight, maternal overweight, SES dummies, residential area, and month of interview. Cluster-robust standard errors at family level in parentheses.

Table 3.3 consists of multivariate analyses of Models 1–4. Adjusted for the control variables, the main effects in Model 1 support the evidence of sibling inequalities in overweight of Tables 3.1–3.2, with the exception of gender. Although Model 1 indicates that boys were at higher odds of overweight than girls, this was not significant (AOR = 1.125). Gender differences in overweight emerged when an interaction with mother's education was introduced from Model 2 onwards. Model 2, for example, shows that boys whose mothers spent more years in school had higher odds of overweight than girls (AOR = 1.052, p-val. < 0.05). In Model 3, mother's education aggravated effects of birth order. This was shown in increased odds of overweight of the eldest by 16.6% for each additional year of mother's education (Model 3: AOR = 1.166, p-val. < 0.05). Multi-way interactions of gender, birth order, and number of siblings were not significant (results are available upon request). Therefore, Table 3 only consists of Models 1–4. Model 3 is the most parsimonious, because it has a marginally higher AIC (Δ AIC = 0.661) but has one parameter less than Model 4: "number of siblings × mother's education," which was not significant either (AOR = 0.981, p-val. > 0.05). Model 3 therefore became the base model for further analyses.

Table 3.4. Main effects and moderating effects of mother's education on consumption of high-calorie foods

	Model 3A	Model 3B	Model 3C
	Coef. (SE)	Coef. (SE)	Coef. (SE)
interaction effects:			
sex × mother's education[b]			
girls	ref .	ref .	ref .
boys	0.034 (0.043)	0.106 (0.050)*	0.145 (0.053)**
birth order[a] × mother's education[b]			
eldest	0.049 (0.081)	0.01 (0.089)	0.039 (0.094)
mid-child	ref .	ref .	ref .
youngest	0.026 (0.074)	0.04 (0.085)	0.076 (0.090)
main effects:			
sex			
girls	ref .	ref .	ref .
boys	0.400 (0.139)**	0.519 (0.167)**	0.589 (0.185)**
birth order[a]			
eldest	0.495 (0.271)	0.605 (0.301)*	0.547 (0.317)
mid-child	ref .	ref .	ref .
youngest	-0.026 (0.260)	0.215 (0.303)	0.243 (0.328)
number of siblings	0.362 (0.103)**	0.368 (0.110)**	0.412 (0.115)**
mother's education[b]	-0.083 (0.033)*	-0.089 (0.038)*	-0.117 (0.041)**
control variables included?	yes	yes	yes
N of children	5827	4195	3534
N of families	4255	3227	2765
R^2	0.022	0.029	0.035

Table 3.4. Continued

	Model 3A		Model 3B		Model 3C	
	Coef.	SE	Coef.	SE	Coef.	SE
R^2-adj.	0.018		0.023		0.027	

** p-val.<0.05, * p-val<0.01
[a] within-family centred birth order dummies.
[b] between-families centred mother's education.
Model 4A (2-19 years), Model 4B (5-19 years), Model 4C (7-19 years).
Coef.s are coefficients adjusted for control variables: child's age, birth weight, maternal overweight, SES dummies, residential area, and month of interview. Cluster-robust standard errors at family level in parentheses.

Table 3.4 sums up the first additional analyses examining the consumption of high-calorie foods as the channel through which mother's education may cause sibling inequalities in overweight. Models 3A–3C are based on Model 3, but we substituted "consumption of high-calorie foods" for "overweight" as the outcome variable. However, no interaction effects were significant in Model 3A (2–19 years). Assuming that the age of children may play a role in when mothers allow their boys and girls to consume high-calorie foods, we developed Models 3B–3C, in which the same analysis is carried out, but for children over 5 years old in Model 3B, and over 7 years old in Model 3C.

The main effect consistently shows that boys consume high-calorie foods more often than girls (e.g., Model 3A: b = 0.400, p-val. < 0.01). Evidence emerged that the eldest consumes high-calorie foods more often, but the evidence for this is relatively weak since it was only significant in Model 3B (b = 0.605, p-val. < 0.05). Overall, children whose mothers had more school years consume high-calorie foods less often (e.g., Model 3B: b = –0.089, p-val. < 0.01), but this did not apply to boys. Models 3B–3C indicate that boys consume high-calorie foods more often for each additional year that the mother spent in school. This pattern seems to be significant from late childhood onwards (Model 3B: b = 0.102, p-val. < 0.05), and increases visibly when children enter school age (Model 3C: b = 0.132, p-val. < 0.01). This is the only pattern we found that reflects the moderating effects of mother's education on sibling inequalities in overweight. Models 3A–3C do not reveal a moderating effect of mother's education on birth order inequalities in the consumption of high-calorie foods.

Table 3.5. Moderating effects of different specifications of SES on overweight

	Model 3D		Model 3E	
	AOR	SE	AOR	SE
interaction effects:				
sex × SES[b]				
girls	1.000	(.)		
boys	1.058	(0.059)		
birth order[a] × SES[b]				

Table 3.5. Continued

	Model 3D		Model 3E	
	AOR	SE	AOR	SE
eldest	1.088	(0.138)		
middle	1.000	(.)		
youngest	1.031	(0.122)		
sex × ln(PCE)				
girls			1.000	(.)
boys			1.228	(0.159)
birth order[a] × ln(PCE)[b]				
eldest			1.310	(0.402)
middle			1.000	(.)
youngest			1.127	(0.328)
main effects:				
sex				
girls	1.000	(.)	1.000	(.)
boys	0.953	(0.170)	0.067	(0.119)
birth order[a]				
eldest	1.091	(0.444)	0.035	(0.145)
middle	1.000	(.)	1.000	(.)
youngest	1.444	(0.541)	0.308	(1.226)
number of siblings	0.883	(0.039)**	0.885	(0.039)**
SES [b]	1.152	(0.049)**		
ln(PCE)			1.345	(0.137)**
other control variables included?	yes		yes	
N of children	6723		6723	
N of families	4784		4784	
Pseudo-R^2	0.044		0.045	
AIC	5696.279		5690.484	

** p-val.<0.05, * p-val<0.01

[a] within-family centred birth order dummies.

[b] linear specification of SES in which SES quartile was treated as a continuous variable.

AORs are odds ratio adjusted for control variables: child's age, birth weight, maternal overweight, mother's education, residential area, and month of interview. Cluster-robust standard errors at family level in parentheses.

Table 3.5 summarises the second set of additional analyses, examining if the moderating effects of mother's education on sibling inequalities in overweight were different to those of SES. Two specifications of SES were used in Model 3D (linear specification of SES) and in Model 3E (*ln*(PCE)). Table 3.5 shows that SES shared no similarity to that of moderating effects of mother's education on sibling inequalities in overweight. None of the interaction effects with gender, birth order, or number of siblings were significant. Unlike Model 3, we also observed that the main effects of birth order on overweight are not significant. Furthermore, Models 3D–3E are also less meaningful than the parsimonious Model 3, because these models have a substantially poorer goodness-of-fit (GOF) (Δ AIC > 10, e.g., Model 3E vs Model 3 = 5690.484–5504.549).

3.5 Discussion

We can now summarise our results in two groups of main findings. First, we found that the eldest and the youngest were more likely to be overweight than middle children. We also found that children who had fewer siblings were at higher odds of overweight. In addition, the more years of formal education the mother had would increase rather than reduce the chances of overweight. However, we did not find that overweight varied by gender. These results, except for gender, supported H1 that sibling inequalities and mother's education affect overweight in children. Second, we found evidence supporting H2 that mother's education aggravated sibling inequalities in overweight. When the interaction terms of mother's education and gender were introduced, gender inequality in overweight became evident. Unlike girls, boys whose mother spent more years in school were at higher odds of overweight than girls. This was also the case for eldest children. Nevertheless, mother's education did not influence overweight for youngest children, or for children with only a few siblings.

Two additional findings emerged. First, we demonstrated that mother's education aggravated gender inequality in the consumption of high-calorie foods. To a certain extent, this pattern reflected our second series of main findings (H2). We found that, overall, boys consumed high-calorie foods more often than girls, but boys whose mothers spent more years in school consumed high-calorie foods even more often. This appeared to increase from late childhood onwards (> 5–19 years of age). However, as opposed to our second series of main findings, evidence of birth order inequalities in the consumption of high-calorie foods is weak. Furthermore, there was no convincing evidence that more educated mothers aggravated birth order effects in the consumption of high-calorie foods. We found that, when adjusted for control variables (including SES), consumption of high-calorie foods increased with more siblings. This might indicate that more siblings leads to reduced supervision of children's diet. Second, we showed that the moderating effects of mother's education are different from those of SES. This suggests that the moderating effects are likely to be associated with the extent of the agency of educated mothers, i.e., influencing children's diets and lifestyle, rather than purely SES background (Smith & Haddad 2000; Smith et al. 2003; Burroway 2016).

Our main findings confirm previous studies on sibling inequalities in overweight, i.e. by gender—after being moderated by mother's education—, birth order, and number of siblings (R. H. Mosli et al. 2015; Ochiai et al. 2012; Madden 2017; R.H. Mosli et al. 2015; Meller et al. 2018; Hu et al. 2017). On the main effects of mother's education, studies in developed countries suggest that children whose mother had more school years are less likely to be overweight (Madden 2017; Ruiz et al. 2016; Apouey & Geoffard 2016). Most of these studies did not explicitly explain the mechanisms underlying this effect. For example, a study in France by Apouey & Geoffard (2016) relied on Baker et al. (2006) and Drewnowski & Specter (2004) on using mother's education interchangeably with family SES—with which we cannot fully agree, based on Table 3.5. They inferred those French children whose mothers spent more years in school were less likely to be overweight, because they came from higher SES families, which were likely to have had better access to healthier nutrient-dense foods.

Literature from developing countries has, however, suggested the opposite. Given their phase in the nutrition transition, in developing countries overweight is still more the problem of higher SES families rather than that of the poor (Aizawa & Helbe 2017; Aizawa & Helbe 2018). Our study supports this. A small-scale study in Bogor, Indonesia, also found that children whose mothers spent more years in school were more often overweight (Ekawidyani et al. 2018). This strongly suggests that the effects of mother's education on overweight in children differs across contexts, in this case across developed vs developing countries.

In both developed and developing countries, mothers who had more school years may share the same trait of being open to new diets and nutrition innovations (Smith & Haddad 2000; Smith et al. 2003), but it might work out differently, depending on the stage in the global nutrition transition (Popkin 1993; Popkin et al. 2012). Developing countries are most likely to be in the fourth stage of the global nutrition transition. In this stage, high-calorie diets become increasingly popular. Perhaps the openness to new diets and nutrition innovations places educated mothers in developing countries at the forefront in terms of adopting unhealthy diets for their children. This may work the opposite way in developed countries, which are mostly in the fifth stage of the global nutrition transition. At this stage, educated mothers might help their children to practice healthy eating habits and a more active lifestyle.

In our study, the odds of overweight were higher for boys whose mother spent more years in school. Our first additional findings provided an explanation for this, by signalling a much higher consumption of high-calorie foods by boys. Perhaps social norms accompanying the body image view that girls should be slim is the reason behind these gender differences (Arimbi 2011). To conform with the norm, mothers might limit consumption of high-calorie foods by their daughters but, concurrently, be less restrictive with their sons. Our findings indicated that educated mothers, those who had more years of formal education, exercised this agency even more, and thereby produced a greater gender gap in overweight. This may be beneficial for girls of educated mothers, but it is certainly harmful to boys.

For birth order, our findings were similar to the study by Ochiai et al. (2012) in Japan, in that the eldest and the youngest had higher odds of overweight than middle children. However, a study in rural China showed results that differed from ours, i.e. higher odds of overweight in later born children, but not in the eldest (Hu et al. 2017). We cannot therefore firmly confirm that the "neglected middle-child hypothesis" applies universally. We examined birth order inequalities further and found that mother's education increased the odds of overweight for the eldest, but not for the youngest. This means that, while it was non-conditional for the youngest, certain characteristics linked to mother's education gave the eldest more exposure to overweight. Perhaps this was bound to the main activity of the eldest. As the role model for their younger siblings, educated mothers might encourage the eldest to stay in school longer, and enter employment at a much later age. A focus on school, with no need to enter employment early, probably lowers the eldest's physical activity and calorie expenditure. The opposite might apply to the eldest children of less-educated mothers. They might exit school earlier and immediately enter employment. This is not necessarily because they need to support the family economy, but can also be because the family places less value on education. With their lower educational level, the eldest in these families can only achieve intensive manual labour roles. These types of jobs burn more calories, thus preventing them from being overweight. These are tentative hypotheses, which require further analyses that go beyond the scope of this study.

Without evidence of moderating effects of mother's education, the results on the relation between the number of siblings and overweight are easier to interpret. Having more siblings meant being less likely to be overweight, and vice versa (Table 3.3). This confirms previous studies, which found that children of small families—particularly those who were an "only child"—were more often overweight (R. H. Mosli et al. 2015; Ochiai et al. 2012; R.H. Mosli et al. 2015; Meller et al. 2018). Two mechanisms were suggested for this association, which link number of siblings and overweight. First, derived from resource dilution theory, more siblings signifies more mouths to feed. With finite parental resources, this means that children of larger families receive a smaller share of the food available than those of smaller families, but the positive side is that this could prevent children from becoming overweight. Second, more siblings mean more physical activity, i.e., more group play (Hallal et al. 2006). A physically active lifestyle burns more calories and helps children maintain a healthy weight. In the Indonesian context, the second mechanism seems to be more applicable. This is because our study shows a negative association of number of siblings and overweight (see Table 3.3), but a positive association between number of siblings and consumption of high-calorie foods (see Table 3.4).

We acknowledge that this study has a number of limitations. Among these are, first of all, the fact that we relied on the cross-sectional design of IFLS-5 (2014/2015). This approach allowed us to portray the recent phenomena of overweight among Indonesian children but limited us to disentangling age effects from those of cohort effects. Based on their study in France, Apouey & Geoffard (2016) suggested that birth cohort might differentiate overweight in children. Future studies should therefore take this into consideration by, for example, pooling additional data from multiple IFLS waves and exploiting its longitudinal design. This longitudinal design should also unlock the possibility to investigate changes in the relationships of mother's education, sibling inequalities, and other factors (e.g., demographics, income, source of food purchase, and family dynamics) impacting overweight in children. Second, we focused on analysing the moderating effects of mother's education. To reduce complexity in interpreting the results, we assumed that the effects of mother's education were linear. Our results suggested that there were indeed linear main and moderating effects of mother's education. However, this was without examining non-linear specifications of mother's education, which could also be important (Madden 2017; Ruiz et al. 2016; Apouey & Geoffard 2016; Liu et al. 2016). This is another area on which future studies could shed more light. Third, although we identified the moderating effects of mother's education on gender inequality in overweight, as reflected in the consumption of high-calorie foods, our explanation of the social pressure that girls should be slim is rather tentative. This is a call for further studies, probably using more qualitative methods, to examine our proposed explanation. Fourth, similar to the third limitation, we explained the moderating effects of mother's education on overweight of the eldest based on rough theories. We proposed that the pressure to study and remain at school longer may expose the eldest children of educated mothers more to overweight. However, future studies are required to uncover the true mechanisms. Fifth, aside from the consumption of high-calorie foods, we included physical activity in our discussion. Unfortunately, even the latest IFLS-5 (2014/2015) does not have data or good proxies for calories burned through physical activities. It limited us to testing alternative channels from which overweight in children might develop. These analyses are critical for knowledge building on overweight issues in children. Therefore, we suggest that future studies should also collect and analyse data on physical activity and lifestyle. Sixth, the educational level of the father is completely absent in this study. It would be interesting for future studies to examine the role of father's education on overweight in children, and whether this is similar to the mother, or more closely mirrors that of SES. Lastly, we did not explicitly study the effects of mother's education in extended family settings, where grandparents might also participate in taking care of children, or in settings where employed mothers may delegate the caregiver roles to others. Indeed, a previous study in Indonesia suggested that the mother's influence on child health was significantly greater than that of the father and grandparents (LaFave & Thomas 2014). However, the mother’s influence in that particular study was proxied by household assets under the mother’s authority. Would the same results hold for mother’s education? This is a question that a future study must address.

In conclusion, we found that the eldest and youngest children, and children from small families, were more likely to be overweight in Indonesia. In contrast to evidence from developed countries that mother’s education reduced the chance of overweight (Madden 2017; Ruiz et al. 2016), children of educated Indonesian mothers experienced the opposite. They were more often overweight. This effect was greater for boys and for eldest children. Overconsumption of high-calorie foods in boys of educated mothers, and a tentative explanation of adherence to a less physically active lifestyle among eldest children of educated mothers, might explain these phenomena. These results should inform governments, policymakers, and communities in developing countries, and particularly in Indonesia, that target groups for nutrition interventions to counteract overweight in children should not exclude educated mothers and their children, particularly boys. Stimulation of a more active lifestyle for the eldest and youngest children, and for children of small families should be integrated into programmes. Educating mothers, including those who had more years of formal education, to better supervise their boys’ diet should also be high on the agenda.

Chapter 4

The effects of prenatal exposure to Ramadan on stature during childhood and adolescence

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Abstract

Many pregnant Muslim women fast during the Muslim holy month of Ramadan. A number of studies have reported negative life outcomes in adulthood for children who were prenatally exposed to Ramadan. However, other studies document minimal to no impact on neonatal indicators. Using data from the Indonesian Family Life Survey consisting of 45,246 observations of 21,723 children born to 9,771 mothers, we contribute to the current discussion on prenatal exposure to Ramadan by examining the effects on stature (height-for-age Z-scores, weight-for-age Z-scores, and body-mass-index-for-age Z-scores: HAZ, WAZ, and BAZ, respectively) from early childhood to late adolescence (0–19 years of age). We introduce an objective mother's religiosity indicator to improve the intention-to-treat estimations. Children were classified into three groups based on their mother's religion-religiosity: religious Muslims, less-religious Muslims, and non-Muslims. Using cluster-robust mother fixed-effects, we found negative effects on stature for children born to religious Muslim mothers. The effects were age-dependent and timing-sensitive. For example, children born to religious Muslim mothers were shorter in late adolescence (15–19 years of age) compared to their unexposed siblings, if they were prenatally exposed in the first trimester of pregnancy (HAZ difference = –0.105 SD; p-val. < 0.05). Interestingly, we found positive effects on stature for exposed less-religious Muslim children that peak in early adolescence (10–14 years of age) and negative effects on stature for exposed non-Muslim children that occur only in early childhood (0–4 years of age). We nuance our discussion of health and socioeconomic factors to explain these surprising results.

4.1 Introduction

Research on the effects of prenatal exposure to Ramadan is as yet inconclusive. Several studies have reported that children who are prenatally exposed to Ramadan are lighter at birth, but most evidence is limited to small differences (Almond & Mazumder 2011; Savitri et al. 2014). Other studies have even reported the contrary, showing a higher birth weight for children whose mother fasted during Ramadan (Alwasel et al. 2011; Savitri et al. 2018). The debate continues because weak to no evidence of negative effects of prenatal exposure to Ramadan has emerged for neonatal indicators (Makvandi et al. 2013; Seckin et al. 2014). Interestingly, many large sample studies analysing adult life outcomes corroborate one another's findings. These large sample studies document not only ill-health in adulthood (Almond et al. 2014; van Ewijk et al. 2013; van Ewijk 2011) but also negative effects on labour outcomes (Majid 2015; Schultz-Nielsen et al. 2016). The evidence regarding negative life outcomes at birth is weak, but a relatively consistent evidence of negative effects in adulthood raises questions on whether prenatal exposure to Ramadan does have effects and whether the effects are age-dependent.

Despite their potential to settle the conflicting evidence at birth versus in adulthood, studies on the effects of prenatal exposure to Ramadan on life outcomes in childhood and adolescence are scarce. Previous large sample studies used intention-to-treat estimations (ITT), using prenatal exposure to Ramadan as the proxy for maternal fasting during Ramadan. Interesting to note is that not all pregnant Muslim women would fast during Ramadan (Bilsen et al. 2016; Joosoph et al. 2004; Mubeen et al. 2012). Therefore, ITT underestimate the real effects of maternal fasting during Ramadan. Previous studies are also uncertain regarding whether maternal fasting during Ramadan is the main cause of negative effects of prenatal exposure to Ramadan, because other factors such as alternating diet and sleep disturbance might also be influential.

We contribute to the current discussion on the effects of prenatal exposure to Ramadan in three ways. First, instead of using the life-cycle approach whereby different life outcomes at different life stages are analysed, we adopt a life-course perspective, analysing stature from early childhood to late adolescence (0–19 years of age). This approach allows us not only to examine whether prenatal exposure to Ramadan affects stature, but also to offer evidence on whether the effects are age-dependent. Second, we improve the current ITT by utilising the mother's religiosity, similar to Majid (2015). However, instead of inferring the mother's religiosity from her adult child's self-reported perceived religiosity as Majid (2015) did, we introduce an objective indicator that directly measures the mother's religious practice. Along with the Ramadan fasting, another one of the five pillars of Islam is the Islamic five daily prayers. We categorise the mother as religious if she is committed to the Islamic five daily prayers. Our rough estimations indicate that the maternal fasting rate during Ramadan for religious pregnant Muslim women is notably higher than that for the less-religious (Tables A4.1-A4.3). We use this association to improve our estimations by differentiating Muslim children based on their mother's religiosity. Third, we tabulate health and socioeconomic factors that may produce different experiences of prenatal exposure to Ramadan for different religion-religiosity groups in Indonesia. The table enables us to be more certain of the probable cause(s) of the effects on stature for different religion-religiosity groups.

We use data from the Indonesian Family Life Survey (IFLS) over the period 1993–2015. The survey consists of 45,246 observations of 21,723 children born to 9,771 mothers. Analysing IFLS data has a significant societal relevance because Indonesia is the country with the largest Muslim majority. Furthermore, Ramadan follows the lunar calendar, which shifts about 11 days each year ahead of the Gregorian calendar. As Ramadan fasting is governed by daylight, people who live in the far southern and northern hemispheres experience varying daylight depending on the month in which Ramadan falls in relation to the Gregorian calendar. Any statistical estimation of the effects of prenatal exposure to Ramadan becomes complicated because each birth cohort experiences a different duration of Ramadan fasting. Indonesia is an appropriate study site for the topic because of its location near the equator, and thus the Ramadan fasting always lasts for about 13 hours a day.

We analyse three standardised measures of stature: height-for-age Z-scores (HAZ), weight-for-age Z-scores (WAZ), and body-mass-index-for-age Z-scores (BAZ). These measurements are based on the World Health Organization's (WHO) growth standard portraying long-term (HAZ) and short-term nutritional status (WAZ, BAZ) in childhood and adolescence (de Onis et al. 2007; de Onis 2007). We used the overlap between Ramadan and pregnancy as the proxy for prenatal exposure to Ramadan. We categorised children in our sample into three religion-religiosity groups in accordance with their mother's religiosity and religion: religious Muslims, less-religious Muslims, and non-Muslims. We expected to find the highest negative effects on stature in the religious Muslims group; the other two groups are used for falsification purposes to identify the probable cause(s) of the exposure effects on stature.

We structure the rest of the chapter as follows. In Section 4.2, we contextualise Ramadan, particularly in Indonesia. In Section 4.3, we review previous studies on prenatal exposure to Ramadan. We start with a general literature review on prenatal exposure to malnutrition and continue with findings from previous studies on the effects of prenatal exposure to Ramadan on various life outcomes from at birth to adulthood. In Section 4.4, we describe the data and methods used, before concluding with results in Section 4.5 and a discussion in Section 4.6.

4.2 Ramadan and the Indonesian context

Ramadan is the ninth month of the Islamic Hijri lunar calendar. During Ramadan, every healthy adult Muslim should fast from dawn to dusk. It is not only food and drink consumption that is forbidden; certain activities including smoking are also banned during daylight hours. After sunset, adult Muslims may break their fast, traditionally with sweet drinks and snacks before dinner. As one of the five pillars of Islam, Ramadan fasting is mandatory (Trepanowski & Bloomer 2010). Some adult Muslims are exempt from it: people who are travelling, those who are too old or sick, and women in their monthly cycle or postnatal period. Pregnant and breastfeeding women are also allowed not to fast if they are concerned about their health or the health of their offspring. However, some interpretations of Islam suggest that these women should fast as soon as their health permits. As fasting alone after Ramadan is not easy, many pregnant Muslim women continue to fast during Ramadan (Mirghani et al. 2003; Robinson & Raisler 2005).

Located in Southeast Asia, Indonesia is home to more than 250 million inhabitants. Nearly 87% of Indonesians are Muslims (Statistics Indonesia 2011). Sleeping patterns are disturbed during Ramadan because most mosques have a morning call to awaken people for prayer and to take breakfast before dawn, locally called *sahur*. Some people go around voluntarily, helping people to awaken so that they will not miss *sahur*. Office hours change to early morning and end a few hours before sunset to allow Muslims to prepare the evening breaking of the fast (Abe 2010). The law mandates employers to give an annual bonus known as *Tunjangan Hari Raya* (THR) before their employees' most important religious day (MoL 1994). Muslims receive this annual bonus at Ramadan. Giving money to family members, donating to the poor—known as *zakat*—, and food price hikes due to high demand for animal-source foods and spices are common during Ramadan. The two-weeks national sugar fest holiday, or *Eid Mubarak*, signals the end of the Muslim holy month.

Information on the Ramadan fasting behaviour of Indonesian pregnant Muslim women is limited. One study showed that 80% of pregnant Muslim women fasted at least one day during Ramadan (Bilsen et al. 2016). The percentage is lower than 87% in Singapore (Joosoph et al. 2004) and 88% in Pakistan (Mubeen et al. 2012). Regarding pregnant Muslim women who fast for a full month, whereas the percentage is as high as 33% in Singapore and 42.5% in Pakistan, only 14% of Indonesian pregnant Muslim women in Bilsen et al.'s (2016) study fasted for a full month. However, it should be noted that Bilsen et al.'s (2016) sample might not reflect the actual maternal fasting rate of the Indonesian population, as the study was based on samples from one private hospital in Jakarta, Indonesia's capital city. Moreover, the sample disproportionally consists of more highly educated pregnant women who can be assumed to be more health conscious and therefore probably might not adhere to Ramadan fasting for health reasons. Another study in the same hospital showed maternal food consumption was lower during Ramadan (Savitri et al. 2018). However, similar to Kiziltan et al. (2005) findings on the dietary intake of Turkish pregnant Muslim women during Ramadan, remedial action to compensate for the low nutrition intake was evident a month after Ramadan. This might allow pregnant Muslim women who fasted during Ramadan to maintain maternal weight gain and thus sustain a healthy pregnancy.

4.3 Effects of prenatal exposure to Ramadan on life outcomes at different life stages

The Foetal Origin Hypothesis (FOH) documents a variety of evidence linking maternal nutrition and foetal development (Harding 2001; Langley-Evans 2014). FOH underlines the importance of maternal blood glucose level. Abstinence from consuming food and drink during the night may cause a 10% fall in a mother's blood glucose level (Casele et al. 1996; Saleh et al. 1989). Although less severe than the effects of complete starvation such in the Dutch Famine studies (Roseboom et al. 2006; Roseboom et al. 2011; Susser & Stein 1994), low blood glucose may still induce metabolic abnormality, so-called accelerated-starvation. Accelerated-starvation makes the mother's body burn fats to produce energy instead of processing food and drink (Malhotra et al. 1989; Metzger et al. 1982). A side effect is an increase in ketone concentration, which causes the blood to become toxic (Herrmann et al. 2001). As mother shares blood circulation with the unborn, the development of specific foetal tissues might be impaired depending on the timing of the exposure to the low maternal blood glucose level (James 1997; Paterson et al. 1967; Saleh et al. 1989). Pregnant Muslim women who fast during Ramadan also experience accelerated-starvation (Arab 2004; Prentice et al. 1983). Their accelerated-starvation might be even worse because they fast during the day when physical activities peak and cannot be simply avoided. Dehydration due to hot temperatures during the day also reduces a mother's blood volume (Tekin et al. 2015) and lowers the amniotic fluid index (Sakar et al. 2015). Both circumstances may create a hostile environment for the unborn to grow healthily.

Epidemiological studies often use birth weight as an early marker of how well the baby is growing during pregnancy (Habibov & Fan 2011; Kelly et al. 2008). Hypothetically, prenatal exposure to undernutrition stunts foetal organ development. Thus, the exposed baby is expected to have a low birth weight and relatively poorer life outcomes in later life stages. However, not all prenatal exposure to such malnutrition is followed by low birth weight. The Dutch Famine is one example (Roseboom et al. 2006; Roseboom et al. 2011; Susser & Stein 1994). Although the famine in winter 1944–1945 meant that the Dutch, including pregnant women, could only consume no more than 800 calories per person a day, birth weight and birth length of babies who were prenatally exposed in the first trimester of pregnancy were not affected (Roseboom et al. 2011; Roseboom et al. 2006). A prompt food supply recovery after the Dutch liberation from the German occupation was thought to improve maternal nutrition and buffer the immediate effects at birth (Roseboom et al. 2011). However, negative effects of the famine proved to be unavoidable in later life stages. Compared to their unexposed siblings, adults who were prenatally exposed to the Dutch Famine in the first trimester of pregnancy experienced health problems more than those who were exposed in later stages of pregnancy (Roseboom et al. 2006; Roseboom et al. 2011; Susser & Stein 1994).

Similar to the findings in Dutch Famine studies, birth weight does not always clearly indicate a malnourished pregnancy due to maternal fasting during Ramadan. Almond and Mazumder (2011), who used data from Michigan, USA, and Savitri et al. (2014), who used data from Amsterdam and Zaanstad in the Netherlands, reported that children who were prenatally exposed to Ramadan in the first trimester of pregnancy were lighter at birth (Almond and Mazumder, 2011: 18 grams; Savitri et al., 2014: 272 grams). However, other studies from Birmingham, UK (Cross et al. 1990), Kashan, Iran (Sarafraz et al. 2014), and Germany (Jürges 2015) showed no effect on birth weight. Several studies even found that children who were prenatally exposed to Ramadan in the third trimester of pregnancy were heavier at birth (Alwasel et al. 2011; Savitri et al. 2018). The inconsistent evidence on birth weight is followed by weak to no evidence on other neonatal indicators, including non-significant differences between exposed and unexposed babies regarding Apgar score (Malhotra et al. 1989) and gestational duration (Hızlı et al. 2011).

Although studies on prenatal Ramadan exposure effects in childhood and adolescence are scarce, some evidence has started to emerge. Analysing height, an unpublished manuscript examining Demographic Health Survey of 37 low- and lower-middle income countries indicated that prenatal exposure to Ramadan reduced Muslim male children's height by as much as 1.2 cm at age 4 years if they were exposed four months before birth (Karimi 2016). Almond et al. found that being prenatally exposed to Ramadan before the third trimester of pregnancy was associated with a higher under-5 mortality rate in Burkina Faso. Another study in the UK found that 7-years-old school-aged Muslim children who were prenatally exposed to Ramadan in early pregnancy had an average cognitive test score 0.05–0.08 SD (standard deviation) lower than unexposed Muslim children (Almond et al. 2014). No study specifically examines the effects of prenatal exposure to Ramadan in adolescence.

Most evidence on the effects of prenatal exposure to Ramadan relates to adulthood. A number of studies have reported ill-health among exposed Muslims. Health problems include shorter and thinner stature in Indonesia (Almond et al. 2014), symptoms of coronary heart disease and type-2 diabetes in Indonesia (Almond et al. 2014), higher risk of sight and hearing problems in Uganda (Almond & Currie 2011), and psychological disorders in Iraq (Almond & Mazumder 2011). Recent studies in economics have gone further by examining the effects of prenatal exposure to Ramadan on labour outcomes (Majid 2015; Schultz-Nielsen et al. 2016). Majid (2015) found that exposed Indonesian Muslim adults worked fewer hours and were more likely to be self-employed. Majid (2015) applied a life-cycle approach, assessing lack in cognitive ability at age 7 to age 14 as the possible channel through which the exposure reduces labour outcomes. Similarly, Schultz-Nielsen et al. (2016) found that exposed Muslim males in Denmark had 2.6% less chance of being employed and also received a lower salary than unexposed Muslim males, on the basis of exposure in the seventh month of pregnancy.

4.4 Data and method

We pool five waves of the IFLS: the largest household panel survey in Indonesia. IFLS collects a wide array of information on economic, health, and social conditions (Strauss, Witoelar & Sikoki 2016). The first IFLS was conducted in 1993/1994 and the following surveys 2, 3, 4, and 5 were conducted in 1997/1998, 2000, 2007/2008, and 2014/2015. The IFLS sampling scheme covers the 13 most populated provinces in Indonesia, representing 83% of the 1993 Indonesian population. The original IFLS-1 (1993/1994) collected data on 7,224 households. The follow-up surveys also collected data on new-borns and split-off households. IFLS has high follow-up rates, thus reducing possible bias due to sample attrition; 92% of IFLS-1 (1993/1994) households participated in IFLS-5 (2014/2015).

There are 83,770 participants interviewed in at least one of the IFLS waves. The IFLS dataset enabled us to trace the biological mother of 40,758 children. We excluded a number of children from this initial sample for several reasons. First, as classifying whether someone was prenatally exposed to Ramadan is sensitive to the exact date of birth, we excluded 3,622 children whose birth date was unknown or inconsistently reported in different IFLS waves. Second, we excluded 7,924 children for whom the height and weight were never measured between the ages of 0 and 19 years. Third, we excluded 349 children whose HAZ, WAZ, or BAZ are biologically impossible based on the World Health Organization (WHO) growth standards (de Onis et al. 2007; de Onis 2007): ± 6 SD from the median for HAZ and WAZ; ± 5 SD from the median for BAZ. Fourth, 1,371 children born in Bali were excluded. Aside from Bali, which is predominantly Hindu, the other IFLS provinces are mainly Muslim. Therefore, children born in Bali might experience prenatal exposure to Ramadan differently than children born in the other IFLS provinces. Fifth, 1,646 children were excluded because they could be misclassified as prenatally exposed to Ramadan (see sub-section 4.2 for details). Finally, we excluded 4,123 Muslim children because data on the religiosity of their mother were not available. The final sample consists of 45,246 observations of 21,723 children born to 9,771 mothers.

Outcome variables

In each IFLS wave, trained nurses collected height (cm) and weight (kg) up to a single digit decimal of all household members who were present during the interview. As children have not yet attained their final stature, we standardised their stature by sex and age by using the WHO growth standards (de Onis et al. 2007; de Onis 2007). Three standardised stature measurements were produced: HAZ as the indicator for height, WAZ as the indicator for weight, and BAZ as the indicator for body mass. These standardised measurements cover childhood and adolescence life stages (0–19 years of age) except for WAZ, for which the WHO provides standardised measurement only during childhood (0–9 years of age) (de Onis 2007).

Explanatory variables

We use three explanatory variables in our analyses: prenatal exposure to Ramadan dummy/dummies), mother's religion-religiosity dummies, and age group dummies. To identify children who were prenatally exposed to Ramadan, a similar approach to that of others in the literature was used, see Majid (2015) and van Ewijk (2011). On average, a full-term pregnancy lasts for 266 days after conception. An individual is considered prenatally exposed to Ramadan if Ramadan overlaps with a full-term pregnancy period. As we categorise children in three religion-religiosity groups, our measure of prenatal exposure to Ramadan is no longer a simple proxy of maternal fasting during Ramadan. Therefore, based on the Indonesian context, we developed Table 4.1 to summarise health and socioeconomic factors that may affect the experiences of prenatal exposure to Ramadan by religion-religiosity groups.

Table 4.1. Different experiences of prenatal exposure to Ramadan by religion-religiosity groups

	religious Muslims	less-religious Muslims	non-Muslims
health related factors:			
maternal fasting[1]	yes, estimated maternal fasting rate CI 90%: [48%, 84%]	yes, estimated maternal fasting rate CI 90%: [4%, 32%]	no
the mother experienced sleep disturbance[2]	yes	yes	yes
the mother has better diet quality compared to other months[3]	yes	yes	no, compared to time during the non-Muslims' religious days
better in-home air quality[4]	yes	yes	no
socioeconomic context:			
food price hike	yes	yes	yes
received THR in Ramadan	yes	yes	(most likely) no
received zakat	yes, if they were poor	yes, if they were poor	no

THR or *Tunjangan Hari Raya* is an annual bonus that by law in Indonesia should be given by employers to employees at least two weeks before the employees' main religious day. CI 90% is 90% confidence interval.

[1] These are rough estimations due to low N=949 observations and very low N=29 pregnancies (see Tables A1-A3 for details). Non-Muslims are obviously unexposed to maternal fasting during Ramadan.

[2] The morning call, *sahur*, and the volunteers who go around helping people to awaken before dawn will of course awaken either Muslims or non-Muslims; either fasting or not.

[3] Despite the fasting, we argue that Muslims' diet quality is probably better during Ramadan relative to other months because, despite food price hikes, they have more money to spend on quality food due to THR and *zakat*. The opposite might apply to non-Muslims, as they most likely do not receive THR or *zakat* at Ramadan but still experience food price hikes.

[4] Kim & Manley (2016) showed that in-home air pollution negatively affects children's stature in Indonesia. As smoking is forbidden during daylight hours, Muslims probably benefit from better in-home air quality during Ramadan.

We code prenatal Ramadan exposure with a single dummy differentiating the unexposed and the exposed children. Another set of dummies is created to analyse the timing-effects of prenatal Ramadan exposure. These dummies categorise the exposed children into three groups: a) exposed in the first trimester (Ramadan starts 0 to 89 days after conception), b) exposed in the second trimester (Ramadan starts 90 to 178 days after conception), and c) exposed in the third trimester (Ramadan starts 179 to 266 days after conception). Unexposed children are the reference group. Some exposed children might be born after their due date and consequently be misclassified as unexposed. These misclassified children could confound the estimations. Therefore, children who were conceived less than 21 days following the end of Ramadan were excluded.

We use mother's religion-religiosity dummies to classify children into three groups: religious Muslims, less-religious Muslims, and non-Muslims. We start the process by differentiating children by their mother's religion: Muslim and non-Muslim. Muslim children are further classified into religious Muslims and less-religious Muslims based on their mother's commitment to the Islamic five daily prayers. In IFLS-4 (2007/2008) and IFLS-5 (2014/2015), adult Muslim participants were asked to indicate how many times a day they prayed. We used this information to develop an innovative measure of mother's religiosity. We classified Muslim children whose mother prayed at least five times a day as religious Muslims. If their mother did not practice the Islamic five daily prayers in either IFLS-4 (2007/2008) or IFLS-5 (2014/2015), we classified them as less-religious Muslims.

We estimated maternal fasting rate for religious Muslims and less-religious Muslims by using logit regression (see Tables A4.1-A4.3 for details). The estimations were based on small sample observations of Muslim adults who were interviewed during Ramadan in IFLS2 (1997/1998) and IFLS3 (2000). The analysis shows that maternal fasting rate during Ramadan differs by mother's religiosity: religious Muslim pregnant women (66%; CI 90%: [48%, 84%]), less-religious Muslim pregnant women (18%; CI 90%: [4%, 32%]). These confidence intervals should be interpreted with cautions because these were based on a low number of observations (N=949) and a very low number of pregnancies (N=29). Non-Muslim mothers definitely did not fast during Ramadan. Concern has been expressed that mother's religiosity may vary in time and that this, therefore, may bias the analyses. We show in Table A4.4 that mother's religiosity in IFLS-4 (2007/2008) is highly correlated with mother's religiosity in IFLS-5 (2014/2015) (Pearson $\chi^2(1)=1.3e+03$, p-val.<0.01), and the immobility index shows that 85.6% of the mothers remain in the same religiosity category in IFLS-4 (2007/2008) and IFLS-5 (2014/2015), thus indicating that mother's religiosity is relatively constant over time.

For age group dummies, we categorised the observations into four groups with 5-year intervals depending on the age at which the measures of stature were collected. The four groups are: a) early childhood (0–4 years of age), b) late childhood (5–9 years of age), c) early adolescence (10–14 years of age), and d) late adolescence (15–19 years of age). These age groups were used to analyse the age-dependency (age-effects) of prenatal exposure to Ramadan.

Control variables

We used a number of control variables to rule out within-sibling confounders. First, we controlled for the child's sex, because previous studies suggested that the proportion of males born to undernourished mothers was lower, indicating the male foetus's inability to adapt to a hostile environment (Almond & Mazumder 2011; van Ewijk 2011). Second, the intra-household allocation of family resources might be different by birth order (Black et al. 2015). Mothers might also vary their Ramadan fasting behaviour from one pregnancy to the next. We used birth order fixed effects to control for these confounding factors. Third, spatial factors including birthplace and current living place might influence within-sibling health. We controlled for effects of birthplace and current living place by using dummies, differentiating born in and living in urban vs rural, Java vs other islands. Fourth, as Ramadan shifts about 11 days ahead per year, controlling for month of birth is critical to separate the effects of prenatal exposure to Ramadan from possible seasonal effects. Month of birth fixed effects were included to control for seasonal effects. Fifth, birth year as a continuous variable was included to account for changes in the overall environment.

Analysis

We used cluster-robust mother fixed-effects regressions to estimate our model specifications. The use of mother fixed-effects regressions restricts any statistical estimation to within-sibling comparison only and therefore cancels out any systematic differences between families, including differences in nutritional intake and genetic variability that may bias the results. Table 4.1 shows that each religion-religiosity group may experience prenatal exposure to Ramadan differently. Therefore, we start the analyses with Model 1, which includes the interaction effects between prenatal Ramadan exposure and religion-religiosity groups as follow:

$$Y_{ijm} = \beta_1\, exp_{jm} + \beta_2\, rel_m + \beta_3\, age_{ijm} + \beta_4\, (exp_{jm} \times rel_m) + \beta_5\, X_{jm} + \varepsilon_{ijm} \qquad (1)$$

Y_{ijm} is the outcome variables (HAZ, WAZ, and BAZ) for observation in IFLS-*i* (*i*=1, 2, …, 5) of individual *j* born to mother *m*, exp_{jm} is prenatal Ramadan exposure dummy (unexposed vs exposed), rel_m is mother's religion-religiosity dummies, age_{ijm} is a vector for age group dummies, X_{jm} is a vector for control variables, and residual ε_{ijm}. rel_m is constant within-sibling and thus omitted in mother fixed-effects estimations. However, we preserve the notation in Model 1 for demonstrative purpose. Model 1 tests the main effects of prenatal exposure to Ramadan differentiated by religion-religiosity groups. We expect to find higher negative effects of prenatal exposure to Ramadan on stature for children born to religious Muslim mothers. The effects are expected to occur more on HAZ, as HAZ reflects a long-term nutritional status.

We then estimate Model 2, which involves three-way interactions of prenatal exposure to Ramadan, mother's religion-religiosity, and age groups. Model 2 allows us to examine age-effects of prenatal exposure to Ramadan on stature, answering the question of whether the effects of prenatal Ramadan exposure develop with age (age-effects).

$$Y_{ijm} = \beta_1\, exp_{jm} + \beta_2\, rel_m + \beta_3\, age_{ijm} + \beta_4\, (exp_{jm} \times rel_m) + \beta_5\, (exp_{jm} \times age_{ijm}) + \beta_6\, (exp_{jm} \times rel_m \times age_{ijm}) + \beta_7\, X_{jm} + \varepsilon_{ijm} \quad (2)$$

The final model is Model 3, whereby we examine whether the age-effects of prenatal exposure to Ramadan on stature are different depending on the timing of the exposure relative to the pregnancy stage (timing-age-effects). Model 3 is based on Model 2, with exp_{jm} being substituted by exp^{*}_{jm}. The exp^{*}_{jm} consists of expanded prenatal exposure to Ramadan dummies: unexposed vs. exposed in the first trimester, exposed in the second trimester, and exposed in the third trimester.

$$Y_{ijm} = \beta_1\, exp^{*}_{jm} + \beta_2\, rel_m + \beta_3\, age_{ijm} + \beta_4\, (exp^{*}_{jm} \times rel_m) + \beta_5\, (exp^{*}_{jm} \times age_{ijm}) + \beta_6\, (exp^{*}_{jm} \times rel_m \times age_{ijm}) + \beta_7\, X_{jm} + \varepsilon_{ijm} \quad (3)$$

Chapter 4

We used cluster-robust standard errors at the mother level because the sample consists of multiple observations of children born to the same mother (Cameron & Miller 2015). As our models involve up to three-way interaction effects, a presentation of the estimation results using a standard regression table would be difficult to interpret. Therefore, we use predictive marginal contrasts to present all the models. These predictive marginal contrasts are analogous to linear combinations of the regression coefficients (Mitchell 2012). The predictive marginal contrasts compare children who were prenatally exposed to Ramadan with their unexposed siblings. A predictive margin of less than zero indicates negative effects on stature due to prenatal exposure to Ramadan, and vice versa. We developed a figure for each religion-religiosity group to present the main effects (Model 1), the age-effects (Model 2), and the timing-age-effects (Model 3) of prenatal Ramadan exposure on stature. The standard regression tables of Models 1–3 are in the supplementary materials (Tables A4.5–A4.7).

4.5 Results

Table 4.2 shows the sample descriptive statistics by religion-religiosity groups. The mean HAZ, WAZ, and BAZ are below zero, indicating that the sample is from an undernourished population. The non-Muslims are, overall, better on stature as they were taller, heavier, and thicker than both religious Muslims and less-religious Muslims. We show additional information on socioeconomic status (SES) using nominal Personal Consumption Expenditure (PCE) as the indicator. High SES has been associated with better health (Blumenshine et al. 2010; Braveman et al. 2005; Shavers 2007). The majority of non-Muslims lived in high SES households (54.65%). This might explain the non-Muslims' better stature. As we used mother fixed effects, the analyses controlled for all observed and unobserved family differences. Therefore, the SES differences do not affect the results. The less-religious Muslims are, on average, a year younger than the other religion-religiosity groups. There are differences in current living place at the time of interview. In contrast to the other religion-religiosity groups, most of religious Muslims lived in an urban area (50.44%) and in Java (62.05%). The majority of less-religious Muslims lived in a rural area (52.62%) and nearly three-quarters of non-Muslims lived in other islands outside Java (74.18%).

The proportion of children in different categories of prenatal Ramadan exposure does not differ by religion-religiosity groups (p-val.=0.18). There are indications of more males than females in all religion-religiosity groups (p-val.=0.08). However, the proportion of males for religious Muslims is lower than that for other religion-religiosity groups (religious Muslims=50.88%; less-religious Muslims=52.81%; non-Muslims=51.97%). This is probably an indication of sex-related child mortality due to prenatal exposure to Ramadan among children of religious Muslim mothers (Almond et al. 2014). However, further studies are required before a firm conclusion could be made. The average family size in all religion-religiosity groups is small, as the percentage of children born as the third child or later was not higher than the total percentage of the first and the second born combined. Birth place differs by religion-religiosity groups (urban vs rural, p-val.<0.01; Java vs other islands, p-val.<0.01), similar to the pattern for living place. This may suggest that the sample had a low migration rate. There are no differences in birth months (p-val.=0.20). More children were born to less-religious mothers (58.73%) after the millennium.

Table 4.2. Sample characteristics

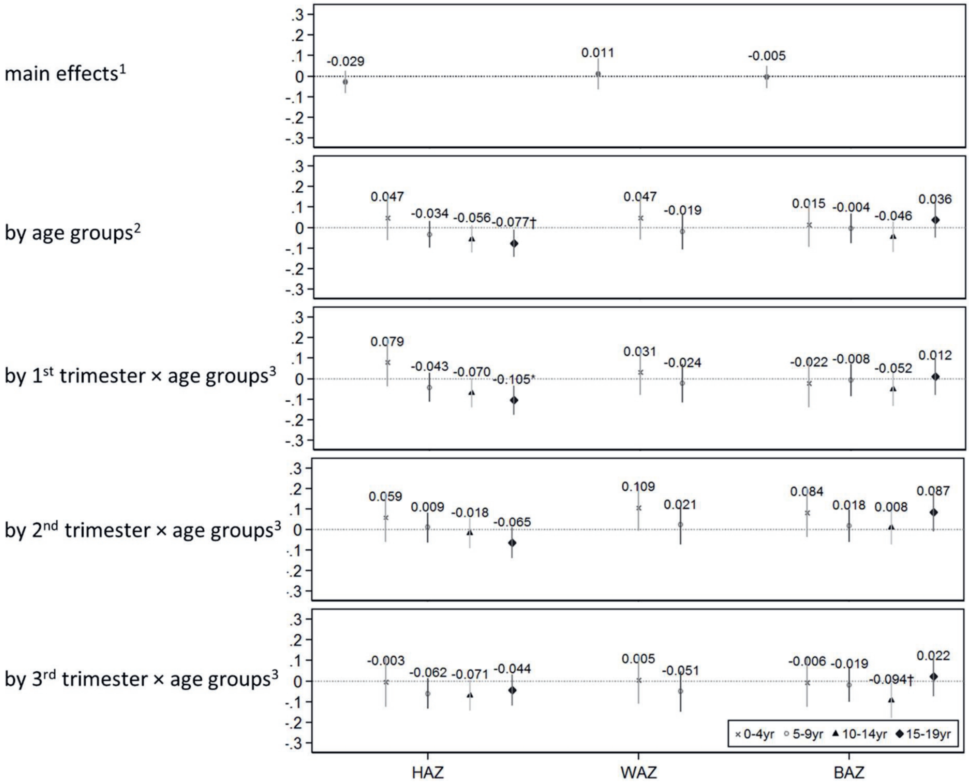
	religious Muslims		less-religious Muslims		non-Muslims		
	Mean	SD	Mean	SD	Mean	SD	p-val.
time-varying characteristics[a]:							
HAZ	-1.55	(1.25)	-1.56	(1.27)	-1.48	(1.36)	<0.01
WAZ	-1.25	(1.27)	-1.23	(1.25)	-1.01	(1.31)	<0.01
BAZ	-0.57	(1.28)	-0.51	(1.28)	-0.29	(1.27)	<0.01
age (in years)	9.24	(5.23)	8.28	(5.12)	9.24	(5.21)	<0.01
lived in urban area (%)	50.44		47.38		49.58		<0.01
lived in rural area (%)	49.56		52.62		50.42		
lived in Java (%)	62.05		40.95		25.83		<0.01
lived in other islands (%)	37.95		59.05		74.18		
low SES (%)	71.30		66.84		45.35		<0.01
high SES (%)	28.70		33.16		54.65		

Table 4.2. Continued

	religious Muslims		less-religious Muslims		non-Muslims		
	Mean	SD	Mean	SD	Mean	SD	p-val.
time invariant characteristics[b]:							
unexposed to Ramadan (%)	10.98		10.48		12.30		0.18
exposed in 1st trimester	34.34		34.27		34.77		
exposed in 2nd trimester	27.47		27.38		27.08		
exposed in 3rd trimester	27.21		27.87		25.86		
males (%)	50.88		52.81		51.97		0.08
females (%)	49.12		47.19		48.03		
1st child (%)	37.39		40.41		33.60		<0.01
2nd child (%)	30.90		31.94		27.63		
3rd child or later (%)	31.72		27.65		38.77		
born in urban area (%)	51.17		48.42		47.27		<0.01
born in rural area (%)	48.83		51.58		52.73		
born in Java (%)	61.69		40.29		25.00		<0.01
born in other islands (%)	38.31		59.71		75.00		
born in January-June	50.89		51.98		52.63		0.20
born in July-December	49.11		48.02		47.37		
born in 1974-2000 (%)	59.52		41.27		59.92		<0.01
born in 2000-2015 (%)	40.48		58.73		40.08		
N of observations[a]	33,654		7,925		3,667		
N of individuals[b]	15,674		4,073		1,976		
N of mothers	7,054		1,884		833		

The p-values are from ANOVA tests for continuous variables and from χ^2-tests for categorical variables. High SES is assigned if children lived in a household with a nominal PCE above the sample mean in a specific IFLS wave. WAZ consisted only of observations of age less than 10 years (0–9 years of age). For WAZ (N of observations/children/mothers): religious Muslims (18,497/12,602/6,273); less-religious Muslims (4,956/3,562/1,769); non-Muslims (2,003/1,468/674).

Figure 4.1 summarises main effects (Model 1), age-effects (Model 2), and timing-age-effects (Model 3) of prenatal exposure to Ramadan on stature for religious Muslims. The figure shows no main effects of prenatal exposure to Ramadan on stature (Model 1). Only when age-dependency is considered (Model 2) do indications of the effects of prenatal exposure to Ramadan on HAZ emerge. Children who were prenatally exposed to Ramadan experienced a lag in height growth compared to their unexposed siblings. This lag in height growth starts in late childhood (5–9 years of age) and becomes significant in late adolescence, as the exposed children are -0.077 SD (p-val.<0.10) shorter than their unexposed siblings. The effects become more evident once the timing-age-effects are considered (Model 3). Children who were prenatally exposed in the first trimester of pregnancy showed a strong pattern of lag in height growth, which led to -0.105 SD (p-val.<0.05) shorter stature compared to their unexposed siblings in late adolescence (15–19 years of age). Although not significant, a similar pattern of lag in height growth also occurred for children who were exposed in the second trimester of pregnancy. There is an indication that children who were prenatally exposed to Ramadan in the third trimester of pregnancy had -0.094 SD (p-val.<0.10) lower BAZ than their unexposed siblings in early adolescence (10–14 years of age). This is probably related to a lower weight in early adolescence as well which, unfortunately, cannot be shown in our estimations because the WHO does not provide WAZ standards for adolescents.



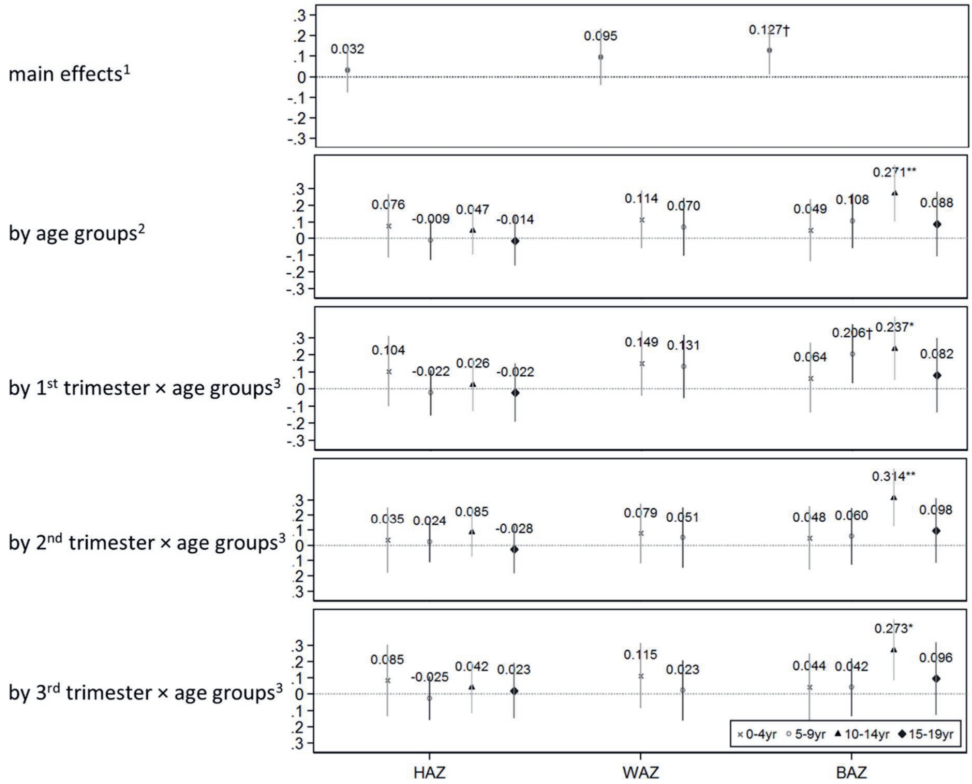
† p<0.10; * p<0.05; ** p<0.01
[1] Model 1; [2] Model 2; [3] Model 3
Unexposed siblings (ref.). Cluster-robust standard errors at mother level. The complete regression tables are in the supplementary materials.

Figure 4.1. Effects of prenatal Ramadan exposure on stature for religious Muslims

We conducted additional analysis to test whether the timing-age-effects on stature differed by sex. For this purpose, we added interaction by sex to Model 3. Table A4.8 shows the predictive marginal contrasts for the timing-age-effects by sex on HAZ and BAZ for religious Muslims. The results indicate that the negative effects on stature are higher for boys than for girls (for HAZ exposed in 1st trimester vs unexposed at late adolescence: boys=-0.126 SD, p-val.<0.05;

girls=-0.004 SD; for BAZ exposed in 3rd trimester vs unexposed at early adolescence: boys=-0.145 SD, p-val.<0.05; girls=-0.091 SD). These indicative findings support the hypothesis that male foetuses are less able than female foetuses to adapt to a hostile environment, see Almond & Mazumder (2011) and van Ewijk (2011) .

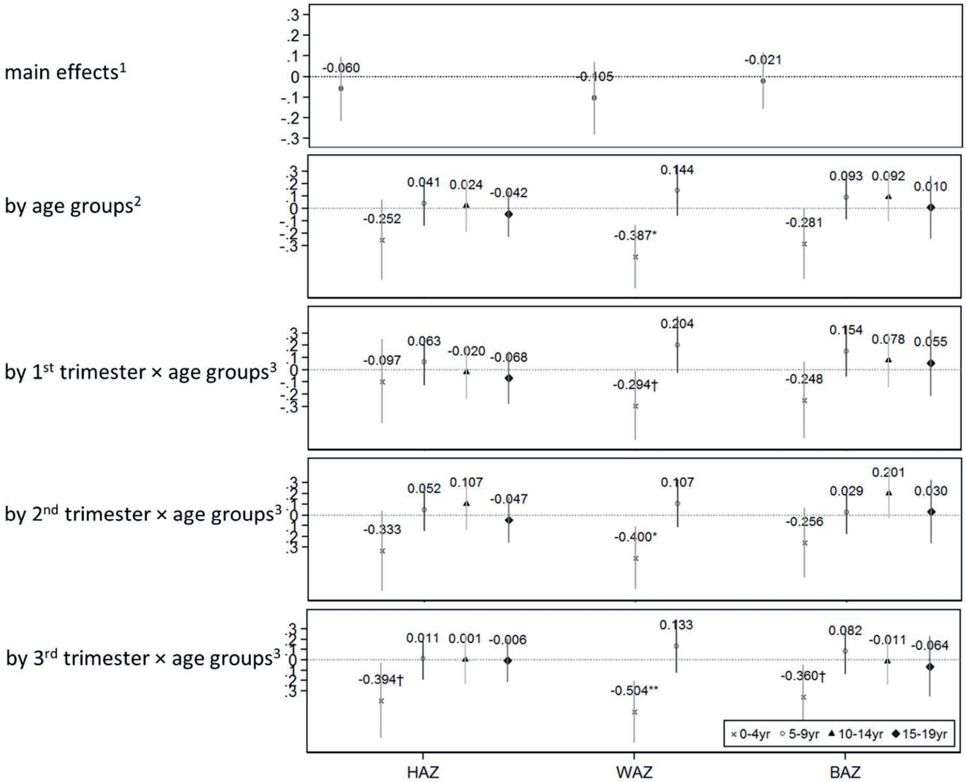
Figure 4.2 visualises the main effects, age-effects, and timing-age-effects of prenatal Ramadan exposure on stature for less-religious Muslims. The less-religious Muslims are an interesting religion-religiosity group because they experience exactly the same exposure to Ramadan as the religious Muslims, except for the lower estimated maternal fasting rate (see Table 4.1). Therefore, the less-religious Muslims group is a strong falsification sample to be certain whether the lag in height growth and the lower BAZ shown in Figure 4.1 are due to maternal fasting during Ramadan. Initially, we expected no effects of prenatal Ramadan exposure in Figure 4.2, because approximately only 18% of less-religious pregnant Muslim women fasted during Ramadan (see Tables A4.1-A4.3 for details). Surprisingly, Figure 4.2 shows indications of positive effects of prenatal Ramadan exposure on BAZ. The main effects shows that those who were prenatally exposed to Ramadan had 0.127 SD higher BAZ than their unexposed siblings. The effects become more evident when age-effects are considered, as Figure 4.2 shows a peak of BAZ in early adolescence (10–14 years of age) (0.271 SD, p-val.<0.01). The higher BAZ of the exposed children when compared to their unexposed siblings seemed to be consistent across the timing-age-effects. For example, those who were prenatally exposed in the first trimester of pregnancy started to have higher BAZ than their unexposed sibling in late childhood (0.206 SD, p-val.<0.10) and peaked in early adolescence (0.237 SD, p-val.<0.05). As there is no evidence of prenatal Ramadan exposure effects on height (HAZ), the higher weight growth in early adolescence might be the factor driving the BAZ peak in early adolescence.



† p<0.10; * p<0.05; ** p<0.01
[1] Model 1; [2] Model 2; [3] Model 3
Unexposed siblings (ref.). Cluster-robust standard errors at mother level. The complete regression tables are in the supplementary materials.

Figure 4.2. Effects of prenatal Ramadan exposure on stature for less-religious Muslims

Figure 4.3 depicts the effects of prenatal exposure to Ramadan on stature for non-Muslims. It should be noted that the non-Muslims experienced exposure to Ramadan differently than the Muslim groups (see Table 4.1). Not only were the non-Muslims unexposed to maternal fasting during Ramadan; they also experienced different health and socioeconomic factors than the Muslims: probable poorer diet quality, no better in-home air quality, different timing of THR, and no *zakat*. There is no evidence of main effects of prenatal Ramadan exposure in Figure 4.3. However, negative age-effects of prenatal Ramadan exposure emerged for WAZ (-0.387 SD, p-val.<0.05) in early childhood (0–4 years of age). The effects on weight in early childhood for those who were prenatally exposed to Ramadan seemed to be greater than those of their unexposed siblings if the former were prenatally exposed at later pregnancy stages (1st trimester=-0.294 SD, p-val.<0.10; 2nd trimester=-0.400 SD, p-val.<0.05; 3rd trimester=-0.504 SD, p-val.<0.01). Those who were exposed in the third trimester of pregnancy had the worse negative effects on stature during early childhood as they were shorter (-0.392 SD, p-val.<0.10), lighter (-0.504 SD, p-val.<0.01), and thinner (-0.358 SD, p-val.<0.10) than their unexposed siblings. Interestingly, these negative effects occurred specifically only in early childhood (0–4 years of age) and did not continue in later ages, thus indicating that exposed children are able to catch up with their unexposed siblings on stature later on.



† p<0.10; * p<0.05; ** p<0.01

[1] Model 1; [2] Model 2; [3] Model 3

Unexposed siblings (ref.). Cluster-robust standard errors at mother level. The complete regression tables are in the supplementary materials.

Figure 4.3. Effects of prenatal Ramadan exposure on stature for non-Muslims

4.6 Discussion

This study is based on a wealth of information on stature during childhood and adolescence from the country with the largest Muslim majority. Our sample contains a greater number of observations than preceding studies that used data from Indonesia, cf. Majid (2015), van Ewijk (2011) and van Ewijk et al. (2013). We analysed stature from early childhood to late adolescence (0–19 years of age), allowing us to offer evidence on whether the effects of prenatal

Ramadan exposure develop with age. Inspired by Majid (2015), we introduce an objective mother's religiosity to improve intention-to-treat estimations; and we contextualise the exposure by tabulating different experiences of prenatal exposure to Ramadan for different religion-religiosity groups.

Our results suggest that prenatal exposure to Ramadan does affect stature. The effects differ by religion-religiosity groups and are age-dependent and timing-sensitive. We present three main findings. First, the exposed children born to religious Muslim mothers experienced negative effects of prenatal exposure to Ramadan on height (HAZ) and body mass (BAZ). Religious Muslims' children who were prenatally exposed to Ramadan experienced a lag in height growth starting from late childhood (5–9 years of age). In late adolescence (15–19 years of age), the lag in height growth caused them to be shorter than their unexposed siblings, particularly if they were prenatally exposed in the first trimester of pregnancy. In addition to this height deficit, in early adolescence (10–14 years of age), religious Muslims' children who were prenatally exposed in the third trimester of pregnancy had lower body mass than their unexposed siblings. Second, the exposed children born to less-religious Muslim mothers experienced effects of prenatal exposure to Ramadan in form of an increased body mass. The effects are apparent even in the main effects and persistent across the exposed trimester of pregnancy, with a peak in body mass during early adolescence (10–14 years of age). Third, we found that non-Muslim children experienced negative effects of prenatal Ramadan exposure on overall stature (HAZ, WAZ, BAZ) if they were exposed in the third trimester of pregnancy. This has never been reported in previous studies. However, unlike those of the exposed religious Muslim children, these exposed non-Muslim children experienced the negative effects only in early childhood (0–4 years of age). At a later age, they were able to catch up to their unexposed siblings in stature.

These results lead us to further interpretations of the effects of prenatal Ramadan exposure on stature. First, we are more certain that maternal fasting during Ramadan is the probable main cause of the negative effects of prenatal exposure to Ramadan for religious Muslims. This is because the only experience of prenatal exposure to Ramadan that differentiates religious Muslims from less-religious Muslims is the higher maternal fasting rate during Ramadan. Second, we suggest that maternal fasting during Ramadan has negative effects that are probably irreversible. We arrive at this interpretation because the exposed non-Muslim children, who can only be prenatally undernourished because of their mother's lower diet quality during Ramadan, are able to catch up on stature at a later age, whereas the opposite is true for the exposed religious Muslims, for whom the negative effects on stature increase with age. Third, there seem to be specific effects of prenatal exposure to Ramadan on weight and body mass in early adolescence (10–14) for Muslim children: negative effects for religious Muslims and positive effects for less-religious Muslims. This might merit further study because the effects occurred during the onset of puberty. Fourth, findings on exposure's positive effects for less-religious Muslims and negative effects for non-Muslims lead us to new hypotheses that may pave the way for further studies. We suggest that the THR and the *zakat* that Muslims receive at Ramadan might unlock their access to quality food and thus improve their diet quality. As their maternal fasting rate during Ramadan is low, the less-religious pregnant Muslim women can benefit their exposed children through improved diet quality during pregnancy. This should give the foetus a better environment in which to grow healthily, see Harding (2001) and Langley-Evans (2014). The opposite happens for non-Muslims. Most non-Muslims do not receive THR or *zakat* at Ramadan but still need to cope with the food price hikes. We argue that the diet quality of non-Muslim mothers during Ramadan is lower than in other months, particularly during the non-Muslims' main religious days. Thus, for non-Muslim children, instead of those who were exposed, it was those who were prenatally unexposed to Ramadan who benefit from a better diet quality and therefore grow better in stature.

For religious Muslim children specifically, we found that negative effects of prenatal exposure to Ramadan on stature developed with age. This evidence should explain why previous studies found very few negative to no effects at birth (Alwasel et al. 2011; Savitri et al. 2018) but reported a number of negative life outcomes in adulthood (Majid 2015; Schultz-Nielsen et al. 2016). The negative effects of prenatal exposure to Ramadan at an early age are probably buffered. Mothers who fast might be able to compensate their low nutrition intake during Ramadan by improving their diet and gaining adequate pregnancy weight a month after Ramadan (Kiziltan et al. 2005; Savitri et al. 2018). This condition is similar to the hypothetical effects of prompt food supply recovery in the Dutch Famine studies that enabled the suppression of the immediate effects of the famine at birth but not in adulthood (Roseboom et al. 2006; Roseboom et al. 2011; Susser & Stein 1994). Regarding timing-age-effects, we found that the negative effects on height in late adolescence (15–19 years of age) were higher for religious Muslims who were prenatally exposed in the first trimester of pregnancy. This finding corresponds with that of Roseboom et al. (2006) on greater health problems in adulthood resulting from exposure to the Dutch Famine in the first trimester of pregnancy. Similar to van Ewijk et al. (2013) who reported the negative effects of prenatal Ramadan exposure on adult stature (18 years or older), we found a height deficit in late adolescence (15–19 years of age) following exposure in the first trimester of pregnancy. However, we could not find any other negative effect on stature except for a lower body mass in early adolescence (10–14 years of age) following exposure in the third trimester of pregnancy. These findings differ from those of van Ewijk et al. (2013), who found negative effects on weight and body mass in adulthood (18 years of age or older) following exposure in the second trimester of pregnancy or later. We suggest that the contrast arises because van Ewijk et al. (2013) analysed stature at an advanced life stage where age-effects become more pronounced. An alternative explanation would be that van Ewijk et al. (2013) used much older birth cohorts than we did. Pregnant Muslim women from an older generation probably have lower pregnancy health status than a later generation. Thus, the older birth cohort might not be protected from negative effects of the exposure on weight and body mass. Such cohort-effects, however, require further studies.

Our study is not without limitations. First, the negative effects on stature that we found for religious Muslims' children might seem clinically subtle compared with findings for prenatal exposure to the Dutch Famine (Roseboom et al. 2006; Roseboom et al. 2011; Susser & Stein 1994). However, in contrast to famines, maternal fasting during Ramadan is an avoidable risk, as pregnant Muslim women can desist from Ramadan fasting at any time. Furthermore, pregnant Muslim women who do not observe the fast could benefit their children through improved diet quality during pregnancy. We aimed to improve our ITT by differentiating the Muslims into religious Muslims and less-religious Muslims. However, the improved diet quality of pregnant Muslim women who did not fast during Ramadan may still bias our estimations downwards on the true size of the negative effects. Some prospective case-control studies are attempting to overcome such underestimation bias by using primary data on actual maternal Ramadan fasting observance (Sakar et al. 2015; Savitri et al. 2014). These studies are still in early phases and are currently limited to early life outcomes. However, because effects of the exposure most likely develop with age, some time is required before any results on later life outcomes become available. Second, we define timing-effects by trimester when prenatal Ramadan exposure started. This approach offered practical interpretations but at the expense of accuracy to signal the exact critical time for being prenatally exposed to Ramadan. Further study focusing specifically on the precise timing-effects could adopt a different design by using month dummies or even days on a continuous scale instead of by trimester. Third, the "positive" effects—an increase in BAZ—that we found for the exposed less-religious Muslims indicated that prenatal Ramadan exposure might benefit a certain group. Our tabulation of different experiences of prenatal Ramadan exposure by religion-religiosity groups indicated that the positive effects probably arose because of the combination of the low maternal fasting rate among the less-religious Muslims and mothers' better diet during

Ramadan. However, to test this hypothetical explanation, further studies are required to collect primary data on the daily dietary intake of pregnant Muslim women during Ramadan.

In conclusion, this study found negative effects of prenatal Ramadan exposure on stature during childhood and adolescence for religious Muslims. The negative effects were most likely due to maternal fasting during Ramadan, developed with age, and were sensitive to the timing of the exposure. As many studies have demonstrated that stature correlates with other life outcomes including cognitive ability (Sánchez 2017), psychosocial aspects (Sohn 2016), and labour market performance (Bargain & Zeidan 2016), any negative effect on stature should not be underestimated. Raising societal awareness that pregnant Muslim women have the right not to observe the Ramadan fast should be top of the agenda for policymakers. However, the aspiration of pregnant Muslim women who want to continue to fast during Ramadan should also be respected. Public healthcare should facilitate, and provide pregnant Muslim women with, better access to maternal healthcare such as additional pregnancy check-ups and dietary advice to help them manage a healthy pregnancy and reduce the negative effects of prenatal exposure to Ramadan for their offspring.

Supplementary Materials

Table A4.1. Sample characteristics for predicting the fasting rate

	not fasting		fasting		
	Mean	SD	Mean	SD	p-val.
religiosity					
less religious (%)	36.91		20.57		<0.01
religious (%)	63.09		79.43		
pregnancy status					
not pregnant (%)	95.27		97.79		0.03
pregnant (%)	4.73		2.22		
sex					
male (%)	40.49		46.99		0.07
female (%)	59.51		53.01		
age (in years)	31.50	(12.05)	31.81	(12.60)	0.71
GHS	6.16	(0.87)	6.24	(0.94)	0.21
lived in					
rural area (%)	48.90		41.14		0.02
urban area (%)	51.10		58.86		
outside Java (%)	57.10		49.21		0.02
Java (%)	42.90		50.79		
IFLS waves					
IFLS2 (1997/1998) (%)	39.12		50.16		<0.01
IFLS3 (2000) (%)	60.88		49.84		
N of observations	317		632		

A number of interviews in IFLS2 (1997/1998) and IFLS3 (2000) coincided with Ramadan. Adult participants were asked whether they were fasting during the day of the interview. GHS is General Health Status assigned by trained nurses (0-9; higher score means the person is healthier than others of the same sex and age). Table A4.1 includes observations of participants ≥15 years of age. The p-values are from ANOVA tests for continues variables and are from χ^2-test for categorical variables.

Table A4.2. Logit model for predicting the fasting rate

	b	SE
religiosity		
less religious	ref	.
religious	0.816	(0.178)**
pregnancy status		
not pregnant	ref	.
pregnant	-1.702	(0.593)**
pregnancy status × religiosity		
pregnant × less religious	ref	.
pregnant × religious	1.421	(0.781)†
sex		
male	ref	.
female	-0.336	(0.140)*
GHS	0.071	(0.089)
age (in years)	-0.004	(0.006)
lived in		
rural area	ref	.
urban area	0.194	(0.180)
outside Java	ref	.
Java	0.072	(0.187)
IFLS waves		
IFLS2 (1997/1998)	ref	.
IFLS3 (2000)	-0.340	(0.186)†
constant	0.243	(0.711)
Log Likelihood	-578.670	
Pseudo-R^2	0.043	

† p-val.<0.10; * p-val.<0.05; ** p-val.<0.01
N of observations = 949; N of individuals = 914; N of households = 589
Based on sample in Table A4.1. Logit regression model is used for predicting the fasting rate. Cluster-robust standard errors at household level in parentheses with 500 bootstrap samples.

Table A4.3. Predictive margin for maternal fasting rate during Ramadan

	Pr(fasting)	SE	p-val.	[90% Conf. Interval]
all religious Muslims	0.72	(0.02)	<0.01	[0.68, 0.75]
all less-religious Muslims	0.52	(0.04)	<0.01	[0.46, 0.58]
religious pregnant Muslim women	0.66	(0.11)	<0.01	[0.48, 0.84]
less-religious pregnant Muslim women	0.18	(0.09)	0.04	[0.04, 0.32]

Based on sample in Table A4.1 and logit model in Table A4.2.

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Table A4.4. Immobility index for mother's religiosity in IFLS4 vs IFLS5

		IFLS5			
		Less religious	religious	missing	Total
IFLS4	less religious	475[b]	595[b]	238[b]	1,308
	religious	453[b]	5,761[a]	1069[a]	7,283
	missing	123[b]	224[a]	0	347
	Total	1,051	6,580	1,307	8,938

[a] religious Muslim mothers = 7,054 mothers; [b] less-religious Muslim mothers = 1,884 mothers
Pearson $\chi2(1)$ = 1.3e+03, p-val.<0.01; Immobility index = (475+5,761)/(475+453+595+5,761) = 0.856. Religiosity data were collected in IFLS4 (2007/2008) and IFLS5 (2014/2015) from participants ≥15 years of age.

Table A4.5. Main effects of prenatal Ramadan exposure on stature (Model 1)

	HAZ		WAZ		BMI	
	b	SE	b	SE	b	SE
exposure						
unexposed	ref	.	ref	.	ref	.
exposed	-0.029	(0.033)	0.011	(0.047)	-0.005	(0.033)
exposure × religion-religiosity						
exposed × religious Muslims	ref		ref		ref	
exposed × less-religious Muslims	0.061	(0.073)	0.085	(0.096)	0.132	(0.079)†
exposed × non-Muslims	-0.031	(0.101)	-0.116	(0.117)	-0.017	(0.090)
age groups						
early childhood	ref	.	ref		ref	
late childhood	-0.044	(0.018)*	-0.264	(0.018)**	-0.323	(0.019)**
early adolescence	-0.004	(0.020)			-0.335	(0.021)**
late adolescence	0.054	(0.022)*			-0.208	(0.024)**
sex						
male	ref	.	ref		ref	
female	0.029	(0.018)†	0.063	(0.024)**	0.174	(0.019)**
year of birth	0.052	(0.004)**	0.047	(0.005)**	0.022	(0.004)**
born in						
rural area	ref		ref		ref	
urban area	0.070	(0.051)	0.11	(0.090)	0.014	(0.053)
other islands	ref		ref		ref	
Java	0.145	(0.202)	0.210	(0.337)	-0.009	(0.247)
lived in						
rural area	ref		ref		ref	
urban area	-0.065	(0.038)†	-0.083	(0.072)	-0.017	(0.042)
other islands	ref		ref		ref	
Java	0.360	(0.184)†	0.259	(0.316)	-0.071	(0.197)
constant	-105.109	(7.205)**	-94.622	(10.051)**	-42.34	(7.066)**
R^2	0.522		0.617		0.461	
R^2-adj.	0.390		0.417		0.311	

† p-val.<0.10; * p-val.<0.05; ** p-val.<0.01

Birth order fixed-effects and month of birth fixed-effects are included in the estimations but are not presented in the table to reduce the table size. Cluster-robust standard errors at mother level in parentheses. WAZ is available for 0-9 years of age only.

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Table A4.6. Effects of prenatal Ramadan exposure on stature by age groups (Model 2)

	HAZ		WAZ		BMI	
	b	SE	b	SE	b	SE
exposure						
Unexposed	ref	.	ref	.	ref	.
Exposed	0.047	(0.065)	0.047	(0.064)	0.015	(0.067)
exposure × religion-religiosity						
exposed × religious Muslims	ref	.	ref	.	ref	.
exposed × less-religious Muslims	0.029	(0.133)	0.066	(0.123)	0.035	(0.132)
exposed × non-Muslims	-0.298	(0.207)	-0.434	(0.168)**	-0.294	(0.187)
age groups						
early childhood	ref	.	ref	.	ref	.
late childhood	0.025	(0.064)	-0.221	(0.067)**	-0.322	(0.071)**
early adolescence	0.083	(0.062)			-0.293	(0.073)**
late adolescence	0.164	(0.066)*			-0.240	(0.078)**
exposure × age groups						
exposed × early childhood	ref	.	ref	.	ref	.
exposed × late childhood	-0.081	(0.067)	-0.067	(0.07)	-0.019	(0.075)
exposed × early adolescence	-0.103	(0.065)			-0.061	(0.075)
exposed × late adolescence	-0.123	(0.069)†			0.022	(0.080)
religion-religiosity × age groups						
less-religious Muslims × early childhood	ref	.	ref	.	ref	.
less-religious Muslims × late childhood	0.008	(0.126)	0.034	(0.137)	-0.005	(0.150)
less-religious Muslims × early adolescence	-0.019	(0.128)			-0.195	(0.146)
less-religious Muslims × late adolescence	0.020	(0.147)			0.047	(0.161)
non-Muslims × early childhood	ref	.	ref	.	ref	.
non-Muslims × late childhood	-0.257	(0.194)	-0.432	(0.179)*	-0.295	(0.188)
non-Muslims × early adolescence	-0.381	(0.207)†			-0.364	(0.196)†
non-Muslims × late adolescence	-0.389	(0.220)†			-0.285	(0.235)
exposure religion-religiosity × age groups						
exposed × less-religious Muslims × early childhood	ref	.	ref	.	ref	.
exposed × less-religious Muslims × late childhood	-0.004	(0.135)	0.024	(0.145)	0.078	(0.158)
exposed × less-religious Muslims × early adolescence	0.075	(0.136)			0.282	(0.155)†
exposed × less-religious Muslims × late adolescence	0.035	(0.157)			0.017	(0.168)
exposed × non-Muslims × early childhood	ref	.	ref	.	ref	.

Table A4.6. Continued

	HAZ		WAZ		BMI	
	b	SE	b	SE	b	SE
exposed × non-Muslims × late childhood	0.373	(0.206)†	0.598	(0.192)**	0.392	(0.201)†
exposed × non-Muslims × early adolescence	0.379	(0.217)†			0.433	(0.206)*
exposed × non-Muslims × late adolescence	0.333	(0.231)			0.269	(0.242)
sex						
male	ref	.	ref	.	ref	.
Female	0.029	(0.018)†	0.063	(0.024)**	0.174	(0.019)**
year of birth	0.052	(0.004)**	0.047	(0.005)**	0.021	(0.004)**
born in						
rural area	ref	.	ref	.	ref	.
urban area	0.070	(0.050)	0.110	(0.090)	0.015	(0.053)
other islands	ref	.	ref	.	ref	.
Java	0.153	(0.204)	0.213	(0.339)	-0.007	(0.248)
lived in						
rural area	ref	.	ref	.	ref	.
urban area	-0.065	(0.039)†	-0.081	(0.072)	-0.017	(0.042)
other islands	ref	.	ref	.	ref	.
Java	0.359	(0.185)†	0.266	(0.318)	-0.072	(0.197)
constant	-105.596	(7.207)**	-94.640	(10.040)**	-43.458	(7.072)**
R^2	0.523		0.618		0.461	
R^2-adj.	0.390		0.417		0.311	

† p-val.<0.10; * p-val.<0.05; ** p-val.<0.01; exp. = exposed; ref = reference
Birth order fixed-effects and month of birth fixed-effects are included in the estimations but are not presented in the table to reduce the table size. Cluster-robust standard errors at mother level in parentheses. WAZ is available for 0-9 years of age only.

Table A4.7. Effects of prenatal Ramadan exposure on stature by pregnancy trimester × age groups (Model 3)

	HAZ		WAZ		BMI	
	b	SE	b	SE	b	SE
exposure						
unexposed	ref	.	ref	.	ref	.
exposed in 1st semester	0.079	(0.071)	0.031	(0.068)	-0.022	(0.073)
exposed in 2nd trimester	0.059	(0.073)	0.109	(0.071)	0.084	(0.074)
exposed in 3rd trimester	-0.003	(0.074)	0.005	(0.071)	-0.006	(0.073)
age groups						
early childhood	ref	.	ref	.	ref	.
late childhood	0.025	(0.064)	-0.223	(0.067)**	-0.323	(0.071)**
early adolescence	0.083	(0.062)			-0.288	(0.073)**
late adolescence	0.164	(0.066)*			-0.234	(0.078)**
religion-religiosity × age groups						
less-religious Muslims × early childhood	ref	.	ref	.	ref	.
less-religious Muslims × late childhood	0.009	(0.126)	0.036	(0.137)	-0.005	(0.15)
less-religious Muslims × early adolescence	-0.019	(0.128)			-0.194	-0.146
less-religious Muslims × late adolescence	0.019	-0.147			0.050	(0.161)
non-Muslims × early childhood	ref	.	ref	.	ref	.
non-Muslims × late childhood	-0.261	(0.194)	-0.438	(0.179)*	-0.298	(0.188)
non-Muslims × early adolescence	-0.381	(0.207)†			-0.363	(0.195)†
non-Muslims × late adolescence	-0.388	(0.221)†			-0.285	(0.235)
exposure × religion-religiosity						
exposed in 1st trimester × religious Muslims	ref	.	ref	.	ref	.
exposed in 1st trimester × less-religious Muslims	0.025	(0.144)	0.118	(0.134)	0.087	-0.143
exposed in 1st trimester × non-Muslims	-0.176	(0.221)	-0.324	(0.183)†	-0.225	(0.205)
exposed in 2nd trimester × religious Muslims	ref	.	ref	.	ref	.
exposed in 2nd trimester × less-religious Muslims	-0.024	(0.150)	-0.030	(0.138)	-0.035	(0.147)
exposed in 2nd trimester × non-Muslims	-0.392	(0.237)†	-0.509	(0.190)**	-0.340	(0.209)
exposed in 3rd trimester × religious Muslims	ref	.	ref	.	ref	.
exposed in 3rd trimester × less-religious Muslims	0.088	(0.153)	0.110	(0.141)	0.050	(0.146)
exposed in 3rd trimester × non-Muslims	-0.391	(0.232)†	-0.509	(0.194)**	-0.353	(0.204)†
exposed in 1st trimester × early childhood	ref	.	ref	.	ref	.
exposed in 1st trimester × late childhood	-0.122	(0.072)†	-0.055	(0.075)	0.014	(0.081)
exposed in 1st trimester × early adolescence	-0.150	(0.071)*			-0.030	(0.082)

Table A4.7. Continued

	HAZ		WAZ		BMI	
	b	SE	b	SE	b	SE
exposed in 1st trimester × late adolescence	-0.184	(0.075)*			0.035	(0.087)
exposed in 2nd trimester × early childhood	ref	.	ref	.	ref	.
exposed in 2nd trimester × late childhood	-0.050	(0.074)	-0.088	(0.076)	-0.066	(0.082)
exposed in 2nd trimester × early adolescence	-0.077	(0.073)			-0.075	(0.083)
exposed in 2nd trimester × late adolescence	-0.124	(0.078)			0.003	(0.088)
exposed in 3rd trimester × early childhood	ref	.	ref	.	ref	.
exposed in 3rd trimester × late childhood	-0.059	(0.075)	-0.056	(0.076)	-0.013	(0.082)
exposed in 3rd trimester × early adolescence	-0.068	(0.074)			-0.088	(0.082)
exposed in 3rd trimester × late adolescence	-0.041	(0.079)			0.028	(0.088)
exposure × religion-religiosity × age groups						
exposed in 1st trimester × less-religious Muslims × early childhood	ref	.	ref	.	ref	.
exposed in 1st trimester × less-religious Muslims × late childhood	-0.004	(0.145)	0.037	(0.156)	0.127	(0.168)
exposed in 1st trimester × less-religious Muslims × early adolescence	0.072	(0.151)			0.202	(0.168)
exposed in 1st trimester × less-religious Muslims × late adolescence	0.058	(0.173)			-0.017	(0.187)
exposed in 1st trimester × non-Muslims × early childhood	ref	.	ref	.	ref	.
exposed in 1st trimester × non-Muslims × late childhood	0.282	(0.220)	0.552	(0.212)**	0.387	(0.224)†
exposed in 1st trimester × non-Muslims × early adolescence	0.226	(0.233)			0.355	(0.23)
exposed in 1st trimester × non-Muslims × late adolescence	0.213	(0.249)			0.268	(0.261)
exposed in 2nd trimester × less-religious Muslims × early childhood	ref	.	ref	.	ref	.
exposed in 2nd trimester × less-religious Muslims × late childhood	0.039	(0.154)	0.059	(0.162)	0.077	(0.174)
exposed in 2nd trimester × less-religious Muslims × early adolescence	0.127	(0.156)			0.341	(0.170)*
exposed in 2nd trimester × less-religious Muslims × late adolescence	0.062	(0.173)			0.046	(0.188)
exposed in 2nd trimester × non-Muslims × early childhood	ref	.	ref	.	ref	.
exposed in 2nd trimester × non-Muslims × late childhood	0.435	(0.243)†	0.594	(0.216)**	0.351	(0.231)
exposed in 2nd trimester × non-Muslims × early adolescence	0.517	(0.254)*			0.532	(0.234)*
exposed in 2nd trimester × non-Muslims × late adolescence	0.410	(0.266)			0.284	(0.280)
exposed in 3rd trimester × less-religious Muslims × early childhood	ref	.	ref	.	ref	.
exposed in 3rd trimester × less-religious Muslims × late childhood	-0.052	(0.155)	-0.035	(0.161)	0.012	(0.175)
exposed in 3rd trimester × less-religious Muslims × early adolescence	0.024	(0.151)			0.317	(0.174)†
exposed in 3rd trimester × less-religious Muslims × late adolescence	-0.021	(0.180)			0.023	(0.188)
exposed in 3rd trimester × non-Muslims × early childhood	ref	.	ref	.	ref	.
exposed in 3rd trimester × non-Muslims × late childhood	0.464	(0.232)*	0.693	(0.217)**	0.454	(0.228)*

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Table A4.7. Continued

	HAZ		WAZ		BMI	
	b	SE	b	SE	b	SE
exposed in 3rd trimester × non-Muslims × early adolescence	0.463	(0.242)†			0.436	(0.225)†
exposed in 3rd trimester × non-Muslims × late adolescence	0.428	(0.256)†			0.268	(0.266)
sex						
male	ref	.	ref	.	ref	.
Female	0.030	(0.018)†	0.065	(0.024)**	0.175	(0.019)**
year of birth	0.052	(0.004)**	0.047	(0.005)**	0.021	(0.004)**
born in						
rural area	ref	.	ref	.	ref	.
urban area	0.068	(0.050)	0.108	(0.090)	0.014	(0.053)
other islands	ref	.	ref	.	ref	.
Java	0.151	(0.203)	0.207	(0.345)	-0.014	(0.250)
lived in						
rural area	ref	.	ref	.	ref	.
urban area	-0.064	(0.039)†	-0.080	(0.072)	-0.017	(0.042)
other islands	ref	.	ref	.	ref	.
Java	0.348	(0.186)†	0.262	(0.322)	-0.069	(0.198)
constant	-105.775	(7.210)**	-94.648	(10.029)**	-43.436	(7.064)**
R^2	0.523		0.618		0.461	
R^2-adj.	0.390		0.417		0.312	

† p-val.<0.10; * p-val.<0.05; ** p-val.<0.01; exp. = exposed; ref = reference

Birth order fixed-effects and month of birth fixed-effects are included in the estimations but are not presented in the table to reduce the table size. Cluster-robust standard errors at mother level in parentheses. WAZ is available for 0-9 years of age only.

Table A4.8. Predictive marginal contrasts for timing-age-effects by sex for religious Muslims

	HAZ				BAZ			
	male		female		male		female	
	diff.	SE	diff.	SE	diff.	SE	diff.	SE
exp. in 1st trimester vs unexposed								
early childhood	-0.002	(0.090)	0.202	(0.085)*	0.081	(0.082)	-0.115	(0.082)
late childhood	-0.059	(0.056)	0.007	(0.056)	-0.095	(0.065)	0.103	(0.062)
early adolescence	-0.030	(0.055)	0.010	(0.054)	-0.047	(0.065)	-0.068	(0.062)
late adolescence	-0.126	(0.055)*	-0.004	(0.057)	0.004	(0.068)	0.019	(0.068)†
exp. in 2nd trimester vs unexposed								
early childhood	-0.063	(0.092)	0.184	(0.087)*	0.080	(0.086)	0.021	(0.083)
late childhood	-0.042	(0.059)	0.005	(0.057)	-0.030	(0.065)	0.057	(0.064)
early adolescence	-0.031	(0.058)	-0.002	(0.056)	-0.077	(0.067)	0.027	(0.063)
late adolescence	-0.076	(0.056)	0.041	(0.059)	0.100	(0.071)	0.025	(0.071)
exp. in 3rd trimester vs unexposed								
early childhood	-0.148	(0.094)	0.196	(0.089)*	0.074	(0.084)	-0.089	(0.083)
late childhood	-0.041	(0.059)	-0.012	(0.057)	-0.052	(0.067)	0.006	(0.063)
early adolescence	-0.004	(0.058)	-0.044	(0.055)	-0.145	(0.068)*	-0.091	(0.062)
late adolescence	-0.042	(0.057)	0.044	(0.058)	-0.009	(0.070)	0.015	(0.071)

† p-val.<0.10; * p-val.<0.05; ** p-val.<0.01
diff. = mean difference; SE= standard errors

Chapter 5

Ethnic group differences in dietary diversity of school-aged children: The roles of gender and household SES

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Abstract

Background: Despite the importance of dietary diversity for nutritional status, studies on issues surrounding ethnicity and dietary diversity in developing countries are limited.

Objective: We analysed cross-ethnic differences in dietary diversity and examined the roles of gender and household socioeconomic status (SES) in three Indonesian ethnic groups with different kinship systems: Javanese (bilateral), Batak (patrilineal), and Minangkabau (matrilineal).

Methods: Data from the Indonesian Family Life Survey (IFLS) 2000–2015 consisted of 6,478 school-aged children (7–12 years of age) born to 3,878 mothers. The children's dietary diversity was measured using a Berry-Index like measurement. We used cluster-robust multivariate linear regressions.

Results: Gendered dietary diversity occurred for ethnic groups with unilineal kinship but was less evident for ethnic with bilateral kinship. Batak and Minangkabau girls, rather than boys, had higher dietary diversity because boys from these two ethnic groups consumed low-status foods, e.g., tubers and vegetables, less often. Household SES influenced ethnic-related dietary diversity differently, perhaps because of food culture. Batak children from lower-SES households consumed fruits and dairy products less often, most likely to enable them to consume the pricier but culturally preferable animal-source foods. This lowered their dietary diversity.

Conclusion: The overall results indicate gendered and household-SES-related effects of ethnicity on dietary diversity. Nutrition interventions for boys should also be on policymakers' agendas. Boys should be advised to consume low-status foods more often to improve their dietary diversity. The Batak case shows that children from lower-SES backgrounds should depend less on the pricier foods to enable them to vary their diet.

5.1 Introduction

Children who consume a wide variety of foods are found to have better nutritional status than those who have a monotonous diet. This fact has been shown for different age groups in diverse contexts: 6–23 months in seven countries (Ethiopia, Mali, Rwanda, Zimbabwe, Cambodia, Nepal, and Colombia) (Arimond & Ruel 2004), 6–59 months in Kuotiala (Mali) (Hatløy et al. 2000), and 6–12 years in two regions in India (Nithya & Bhavani 2016). This suggests that dietary diversity is an important determinant of child nutritional status.

Despite its importance, practicing dietary diversity in everyday life is not without challenges. Gender and socioeconomic status (SES), for example, may alter children's dietary diversity through intra- and inter-household bias in food allocation. In the patrilineal societies of South Asia, where men tend to have a higher status, discrimination against girls and young women in food allocation is not unusual, probably because the female contribution to the household economy is perceived to be low. Bose (2011) and Das Gupta (1987) reported that Indian girls consumed pricier high-status foods such as animal-source foods (e.g. meat, fish, and eggs) and dairy products (e.g. milk) less often than boys. Recently, Aurino (2017) found gender gaps in milk and meat consumption disfavouring school-aged and adolescent Indian girls. In Nepal, adolescent girls and young women ate last (Gittelsohn et al. 1997) and, in poor Hindu communities, they even had to content themselves with the leftover food (Madjdian & Bras 2016). Such discriminations limit female access to nutritious foods and thus may put their diet quality at risk.

Studies in developed countries have shown that dietary quality, of which dietary diversity is one of the most important components, differs by SES. Drewnowski & Specter (2004) found that, because of their limited financial resources, low-SES individuals have a reduced access to healthy, nutrient-dense foods (e.g., whole grains, lean meats, fish, low-fat dairy products, fresh vegetables, and fruits) compared with high-SES individuals. Turrell et al. (2003) found that low-income households in Australia, regardless of the educational level of the household head, were less likely to purchase foods that are high in fibre and low in fat, salt, and sugar. The evidence indicated differential food access by SES that may cause low-SES household members to consume a lesser variety of foods.

In the current literature, gender bias in dietary diversity has been studied mostly in South Asian societies where patrilineal kinship prevails (Madjdian & Bras 2016; Gittelsohn et al. 1997). Furthermore, socioeconomic differences in dietary diversity have not been examined thoroughly for developing countries, cf. Darmon & Drewnowski (2008) and Turrell et al. (2003). This study extends previous literature on food consumption by assessing how dietary diversity in a developing country differs across ethnic groups with different kinship systems and by analysing how gender and household SES may influence dietary diversity differently for different ethnic groups.

Indonesia is an appropriate site to study such a topic because the developing country is home to multiple ethnic groups with a wide spectrum of kinship systems and food cultures. We used food consumption data from three most recent waves of the Indonesian Family Life Survey (IFLS) over the period 2000–2015 to compare the dietary diversity of school-aged children (7–12 years of age) born to mothers in three ethnic groups with different kinship systems: the bilateral Javanese, the patrilineal Batak, and the matrilineal Minangkabau. We also examined the extent to which gender inequality and household SES affect dietary diversity across these ethnic groups.

This paper continues with a brief review of the Indonesian context, focusing on the gender norms, kinship systems, and food cultures of the Javanese, the Batak, and the Minangkabau. We then state our hypotheses before describing the data, measures, and methods. The results follow. We conclude the paper with a discussion of the main findings and their significance for theory building and policy making.

5.2 The Indonesian context: gender norms, kinship systems, and food culture

Located in Southeast Asia, Indonesia is the world's fourth largest country in terms of population, with over 250 million people (Statistics Indonesia 2011; Ananta et al. 2015). Although Indonesia is an emerging middle-income country, malnutrition, including stunting, is still prevalent, affecting more than 37% of children under 5 years of age in 2013 (Fanta Project 2014). The trend continues into adolescence and, surprisingly, boys have a lower nutritional status than girls at this life stage (Kunto & Bras 2018; Fanta Project 2014). During the New Order regime (1966–1998), the national family planning programme was established to accelerate economic growth. The programme promoted the norm of the small, happy, and prosperous family (Lubis 2003). Interestingly, its slogan 'Two children are enough, whether boys or girls' emphasised not only on the small family but also the equality of sons and daughters, in this way attempting to inculcate an egalitarian gender norm (Lubis & Niehof 2003).

There are more than 1,300 ethnic groups living in Indonesia (Statistics Indonesia 2011; Ananta et al. 2015). These ethnic groups vary immensely in kinship systems, ranging from the patrilineal Batak, to the bilateral Javanese, and the matrilineal Minangkabau (Hugo 2015; Fernandez & Kambhampati 2017). The three ethnic groups are the main interest in this study.

The Javanese is the largest ethnic group in Indonesia, while Batak is the fourth largest and Minangkabau is the seventh largest. These ethnic groups comprise 40.06%, 3.58%, and 2.73% of the Indonesian population, respectively (Statistics Indonesia 2008; Ananta et al. 2015).

Kinship systems govern how gender is stratified within society. Among the patrilineal Batak, for whom inheritance of property and family name are patrilineal (Rodenburg 2013), daughters retain no rights in their father's house once married. As Batak people are traditionally virilocal, married daughters must enter their husband's clan and live with the husband's family, where their status as a daughter-in-law is low. This is different from the bilateral Javanese whose daughters experience a relatively more equal position to sons. The lineage of the father and the lineage of the mother are equally important for the Javanese (Frankenberg & Thomas 2001). Daughters also receive inheritance rights (Barlinti 2014). Given the absence of strict residence rules in their kinship system and influenced by the vast development in Java, the Javanese tend to establish their new household apart from the parental household after marriage (neolocality). This also contributes to a better position within the household for Javanese married daughters.

In contrast to the other two ethnic groups, the social system of the matrilineal Minangkabau is rather enigmatic. Their inheritance of property, family name, and traditional place of living after marriage are determined by the mother's lineage. However, Minangkabau communities are not matriarchal (Fernandez & Kambhampati 2017; Blackwood 2000). Matrilocality gives senior women the highest authority within the household, but males dominate leadership in the public domain and in religious positions (Blackwood 2000; van Reenen 2013). The high status of males in the public sphere conforms with Islam: the dominant religion of the Minangkabau (Ananta et al. 2015). The 'small family' norm of the national family planning programme causes many new Minangkabau families to live separately from their matricin (Fernandez & Kambhampati 2017; van Reenen 2013). Such neolocal households reduce the authority of senior women and increase the bargaining power of the father of the conjugal family. The tradition of outmigration (called *merantau*) is common among young Minangkabau males, giving them the means to prove their worth and to improve their position within their ethnic group (Hugo 2015; Ananta et al. 2015).

The three ethnic groups have different food cultures. The Batak's *Jambar-Juhut* tradition, which regulates how to share meat at cultural events (e.g., birth, marriage, and death ceremonies) may leverage the importance of animal-source foods among the Batak (Simatupang & Simatupang 2016; Siahaan 1993), who often consume fish-based dishes (*arsik*) and meat-based dishes (*saksang*) along with cassava leaf. The Javanese's daily diet traditionally includes a lot of vegetables, such as salads with peanut sauce (*pecel*) and fermented soybean or *tempe*. People in Java stigmatise cassava negatively as a low-status food and a symbol of poverty (van Der Eng 1998). The Minangkabau diet is similar to that of the Batak but with less importance placed on animal-source foods in their tradition. Their famous meat dish, *rendang*, was historically created to preserve animal-source foods for the long *Haj* journey (Rahman 2016). The Minangkabau usually consume *rendang* along with a small portion of steamed cassava leaf.

5.3 Hypotheses

We propose three hypotheses. First, as the Batak and the Minangkabau diets consist of more meat than the Javanese diet, such ethnic-related food cultures may cause differences in dietary diversity between ethnic groups. This leads to our first hypothesis: Dietary diversity differs by ethnic group (H1).

Second, we expect that, particularly among the Batak, conformity to male high status may favour the allocation of the pricier high-status foods to boys in a similar way as in the patrilineal South Asian societies. Therefore, our second hypothesis is: Gender inequality in dietary diversity occurs among the patrilineal Batak, where Batak girls have a lower dietary diversity than boys (H2).

Third, the positive association between SES and dietary diversity may also apply to Indonesia (Darmon & Drewnowski 2008; Turrell et al. 2003). However, given the divergent ethnic-related food cultures, SES effects on dietary diversity may vary across ethnic groups. Animal-source foods are central in the Batak tradition and, therefore, the Batak perhaps spend their money more on meat regardless of SES and even though meat is expensive in Indonesia (Indonesia Investment 2017). This could limit spending on other food types among lower-SES Batak households, potentially reducing their children's dietary diversity. We devised our third hypothesis as follow: The association between household SES and dietary diversity varies between ethnic groups. Batak children from lower-SES households might have a lower dietary diversity than those from higher-SES Batak households (H3).

5.4 Methods

Data were derived from the Indonesian Family Life Survey (IFLS): the largest ongoing household panel survey on socioeconomic and health conditions in Indonesia (Strauss, Witoelar & Sikoki 2016). The first IFLS was conducted in 1993/1994. Subsequently, four follow-up surveys were carried out in 1997/1998, 2000, 2007/2008, and 2014/2015. The IFLS sampling scheme encompassed the 13 most populated provinces in Indonesia, representing 83% of the national population in 1993. The original IFLS–1 (1993/1994) interviewed 7,224 households. In the later survey iterations, data from new-borns and split-off households of these original households were also collected. Any possible bias resulting from data attrition is minimum because the IFLS has high follow-up rates; 92% of IFLS–1 (1993/1994) households participated in IFLS–5 (2014/2015).

Ethical Consideration

IFLS data are accessible from the RAND Corporation website. The data are open access for registered users. According to RAND, IRBs (Institutional Review Boards) in the United States (at RAND) and in Indonesia at the University of Gadjah Mada (UGM) have reviewed and approved the IFLS–3 (2000), IFLS–4 (2007/2008), and IFLS–5 (2014/2015) surveys and procedures. These are the survey waves used in this study. RAND stated that all requirements for consent for adults and children were met and approved by the two IRBs prior to fieldwork.

Data Sample

A total of 83,770 individuals participated at least once in the IFLS surveys. However, only 20,261 of them have ever been interviewed at school age (age 7–12 years). We further excluded a number of children from this initial sample for a number of reasons. First, information on food consumption is available only from IFLS–3 (2000) onwards. Therefore, 4,688 children were excluded because they were interviewed before IFLS–3 (2000). Another exclusion of 218 children followed, because their information on food consumption was incomplete or missing. Second, not all mothers reported which ethnic group primarily influenced their household daily activities. Inter-ethnic marriage probably made such a question difficult to answer (Hugo 2015). For this reason, this study excluded 1,844 children for whom data on ethnicity was missing. Third, the interest of this study is on Javanese, Batak, and Minangkabau children. Thus, we excluded 6,833 children born to other ethnic groups. Fourth, additional variables that were included in the analyses reduced the sample further. We excluded 198 children because of missing data on household SES and another two children because of missing data on the mother's education. As a result, the final sample consisted of 6,478 children born to 3,878 mothers.

Outcome variables

Starting from IFLS–3 (2000), the IFLS collected data on the number of days on which a child consumed a certain food type in the week before the interview. These were the only food consumption data available in IFLS at individual level. The data collection was carried out in a household setting where mothers of children younger than 11 years old usually answered the questions (Strauss, Witoelar & Sikoki 2016).

Ten food types were surveyed in IFLS–3 (2000) and IFLS–4 (2007/2008): tubers, eggs, fish, meat, dairy products, green leafy vegetables, banana, papaya, carrot, and mango. The later IFLS–5 (2014/2015) added consumption of seven contemporary food types: instant noodles, fast food, soft drinks, hot chilli, fried snacks, rice, and sweet snacks. Most indexes of dietary diversity consider only healthy food types (Drescher et al. 2007). As the healthiness of those seven contemporary food types is questionable, we used only the first ten food types grouped into five food groups: 1) tubers; 2) vegetables (green leafy vegetables and carrot); 3) fruits (banana, papaya, and mango); 4) animal-source foods (eggs, fish, and meat); and 5) dairy products.

We designated the highest number of days of consumption of a certain food type from each food group as food consumption frequency. We then harmonised the food consumption frequency measure in IFLS–3 (2000) to a continuous scale similar to that of the later IFLS waves: did not consume = 0; 1 day = 1; 2 to 3 days = 2.5; 4 to 6 days = 5; every day = 7. From these food consumption frequency data, we computed the main outcome variable: dietary diversity.

There is little consensus on how to measure and operationalise dietary diversity, because of differences in the number of food groups, the reference periods, and the calculation approaches (Drescher et al. 2007). The methods to validate the dietary diversity index are also far from being homogeneous (Ruel 2003; den Hartog et al. 2006). As we had a limited number of food groups (five) and a 7-day reference period for food consumption frequency, we decide to use a Berry-Index like score to measure dietary diversity. This decision was made because this index considers not only the number of food groups (count index) but also the evenness of consumed food groups (distribution index) (Drescher et al. 2007). We were unable to validate our Berry-Index score against nutrient adequacy because there were no data on the portion size of foods that the children consumed. Therefore, we have to rely on external criteria to validate the Berry-Index score (den Hartog et al. 2006). Table A5.1 shows a significant positive correlation between our proposed Berry-Index score and child nutritional status (height-for-age Z-scores), thus indicating some degree of validity of the Berry-Index score.

The basic Berry-Index (BI) formula is $BI = 1 - \Sigma s_i^2$, where s_i is the share of consumed food i to the total dietary intake (Drescher et al. 2007; Berry 1971; Katanoda et al. 2006). We define s_i as equal to $n_i/\Sigma n_i$, where n_i is the food consumption frequency of food group i. The Berry-Index score varies from 0 to 0.8, with a higher Berry-Index score meaning higher dietary diversity. The food consumption frequencies n_i of the five food groups are additional outcome variables to understand the children's dietary composition.

Explanatory variables

Three sets of explanatory variables were used: ethnic group, gender, and household SES. For ethnic group, we constructed a set of dummy variables indicating Javanese, Batak, and Minangkabau. The dummy for gender was based on the child being either a boy or a girl. We calculated the nominal Personal Consumption Expenditure (PCE) from IFLS data based on Witoelar (2009). We normalised the nominal PCE to a real PCE by taking average prices in Jakarta, the capital city, in 2014 as the baseline. We used real PCE in million Rupiah (1 million Rupiah=US$83,77 in 2014) as an indicator for household SES.

Control variables

Several control variables were included to correct for potential confounders: 1) child's age, 2) mother's education, 3) household composition (sibling size, birth order), 4) food supply (urban/rural, Java-Bali/outside Java-Bali, dry/rainy seasons), and 5) IFLS fixed-effects. First, we used the child's age to control for age-related differences in the portion size and the types of food consumed. Second, educated mothers might also be able to influence their children's eating behaviour more (Burroway 2016; Kunto & Bras 2018). For this reason, we used the mother's completed years of schooling (0–12 years) as a control variable. Third, sibling size and birth order might affect intra-household food distribution and inter-household food selection (Deaton & Paxson 1998). We included both sibling size (on a continuous scale) and birth order (as dummies) to control for household composition. Fourth, food supply may differ by the child's place of residence and seasonality (Gregory et al. 2005; Spencer et al. 2017). This study used residential area (urban vs. rural, Java-Bali vs. outside Java-Bali) and seasonality (interviewed in the dry season: May–October vs. the rainy season: November–April) as control variables for food supply. IFLS fixed-effects, which are dummies indicating the IFLS waves, were included to control for time-variant factors including, but not limited to, macro-level dietary transitions (Popkin et al. 2012).

Analysis

We employed a series of multivariate regression models. We started with a basic regression model specified as follows:

$$Y_i = \beta_1\ ethnic_i + \beta_2\ sex_i + \beta_3\ PCE_i + \beta_6\ X_i + \varepsilon_i \qquad (1)$$

where Y_i is the Berry-Index score and food consumption frequencies of child *i*, $ethnic_i$ is a vector for the ethnic group dummies, sex_i is the child's gender, PCE_i is real PCE, X_i is a vector of the control variables, and residuals ε_i. Model 1 evaluated the main effects of ethnic group dummies on dietary diversity, testing H1 on ethnic group differences in dietary diversity adjusted for sex_i, PCE_i, and control variables X_i.

In Model 2, we interacted $ethnic_i$ and sex_i. This model tested our H2 about gender differences in dietary diversity by ethnic group.

$$Y_i = \beta_1\ ethnic_i + \beta_2\ sex_i + \beta_3\ PCE_i + \beta_4\ (ethnic_i \times sex_i) + \beta_6\ X_i + \varepsilon_i \qquad (2)$$

In Model 3, we then interacted $ethnic_i$ and PCE_i and tested H3 on SES differences (PCE) on dietary diversity by ethnic group.

$$Y_i = \beta_1\ ethnic_i + \beta_2\ sex_i + \beta_3\ PCE_i + \beta_5\ (ethnic_i \times PCE_i) + \beta_6\ X_i + \varepsilon_i \qquad (3)$$

This study used multivariate linear regression models to estimate Models 1–3. As children were nested within the same mother, we used cluster-robust standard errors at the mother level to correct for clustering among children born to the same mother. To show clearly the main effects of ethnic groups and the moderating effects within each ethnic group by gender and by PCE, we used three figures: 1) predictive margins of dietary diversity differed by ethnic groups (Model 1), 2) marginal contrasts of dietary diversity differed by *ethnic* × *sex* (Model 2), and 3) marginal effects of dietary diversity differed by *ethnic* × *PCE* (Model 3). In the figures, we assigned labels only for margins that were significant (at least p-val.<0.05). The regression tables for calculating linear combinations of these margins and the complete tables of the margins we used to create the figures are provided in the appendices (see Tables A5.2–A5.7).

5.5 Results

Table 5.1 presents the sample descriptive statistics. Unadjusted ANOVA and χ^2-tests were used to explore differences in sample characteristics by ethnic group. Except for seasonality and IFLS waves, other characteristics in Table 5.1 varied significantly by ethnic group (p-val. < 0.05). Javanese children had a slightly higher average Berry-Index, indicating a marginally higher dietary diversity than the other two ethnic groups. Batak children's diet consisted more often of vegetables (5.33 days per week) and animal-source foods (5.59 days per week) than the other two ethnic groups. However, compared to the Javanese, they consumed fruits (1.90 days per week) and dairy products (1.55 days per week) less often, whereas Minangkabau children consumed tubers (0.63 days per week) and vegetables (3.41 days per week) less often. The average nutritional status, height-for-age Z-scores (HAZ) and BMI-for-age Z-scores (BAZ), was below the median of the World Health Organization (WHO) growth standards, indicating that children from all three ethnic groups were undernourished. The Batak children suffered most from a long-term nutritional problem, as their HAZ was very low (-1.81 SD). Unlike children from the other two ethnic groups, the majority of Batak children lived in a rural area (58.49%). More boys than girls were interviewed, particularly for the Minangkabau (boys = 56.54%). On average, Batak children were slightly older (10.08 years) and born to a larger family (average sibling size = 3.40) with a lower average SES (real PCE in million Rupiah = 1.03) than the other two ethnic groups. Similar to those of the Minangkabau, mothers of Batak children spent almost one year more in school than the Javanese mothers did (Batak vs Javanese: average mother's education = 7.40 vs 6.52 years).

Table 5.1. Sample characteristics

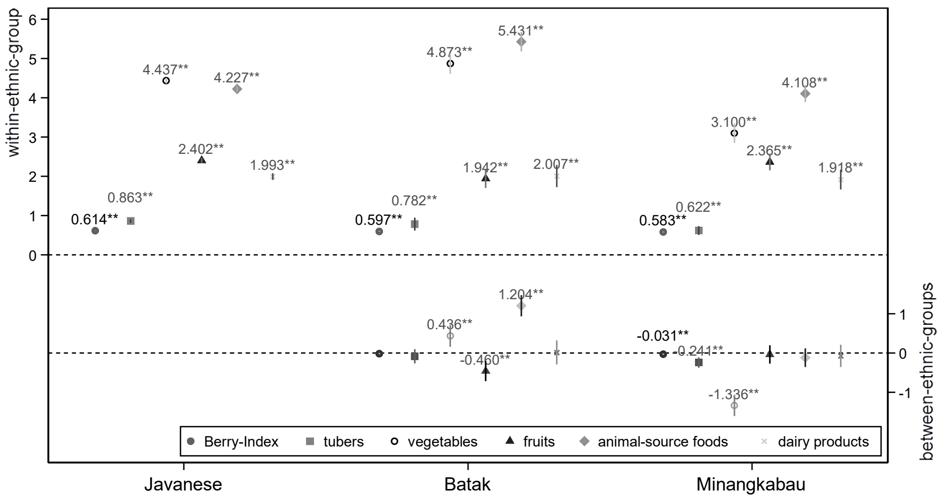
		Javanese		Batak		Minangkabau		
		Mean	SD	Mean	SD	Mean	SD	p-val.
dietary and nutritional status[a]								
Berry-Index score		0.61	0.15	0.60	0.15	0.59	0.17	<0.01
food consumption	tubers	0.85	1.44	0.90	1.52	0.63	1.11	<0.01
	vegetables	4.34	2.55	5.33	2.41	3.41	2.70	<0.01
	fruits	2.42	2.17	1.90	2.10	2.30	2.22	<0.01
	animal-source foods	4.17	2.17	5.59	2.03	4.39	2.19	<0.01
	dairy products	2.05	2.76	1.55	2.55	1.91	2.77	<0.01
nutritional status[1]	height-for-age Z-scores	-1.41	1.09	-1.81	1.07	-1.44	1.11	<0.01
	BMI-for-age Z-scores	-0.58	1.33	-0.34	1.06	-0.48	1.27	<0.01
child characteristics[a]								
gender	boys (%)	52.10		55.27		56.54		0.04
	girls (%)	47.90		44.73		43.46		
age (in years)		9.88	1.73	10.08	1.74	9.94	1.70	<0.01
birth order	first (%)	42.64		27.46		35.02		<0.01
	second (%)	29.12		23.83		29.11		
	third and later (%)	28.24		48.71		35.87		

Table 5.1. Continued

		Javanese		Batak		Minangkabau		
		Mean	SD	Mean	SD	Mean	SD	p-val.
family characteristics[b]								
sibling size		2.35	1.17	3.40	1.52	2.77	1.12	<0.01
mother's education (in years)		6.52	4.55	7.40	5.00	7.48	5.01	<0.01
real PCE (in million Rupiah)		1.23	1.11	1.03	0.65	1.33	1.11	<0.01
residential area	urban (%)	52.23		41.51		56.00		<0.01
	rural (%)	47.77		58.49		44.00		
	Java & Bali (%)	81.14		5.66		5.50		<0.01
	outside Java & Bali (%)	18.86		94.34		94.50		
seasonality	dry season (%)	52.88		49.81		52.25		0.62
	rainy season (%)	47.12		50.19		47.75		
IFLS wave	IFLS-3 (2000) (%)	28.94		32.45		29.75		0.64
	IFLS-4 (2007/2008) (%)	30.53		26.42		29.50		
	IFLS-5 (2014/2015) (%)	40.52		41.13		40.75		
N of children[a]		5,188		579		711		
N of mothers[b]		3,213		265		400		

Unadjusted ANOVA tests with cluster-robust standard errors at mother level were used to analyse ethnic differences for continuous scale variables; unadjusted χ2-tests were used to analyse ethnic differences for dummies/categorical variables. Height-for-age Z-scores and BMI-for-age Z-scores are based on the WHO growth standards 2007.
[1] Because of missing data for anthropometric measurement, N of children/mothers: Javanese = 5,105/3,175; Batak = 573/264; Minangkabau = 690/394.

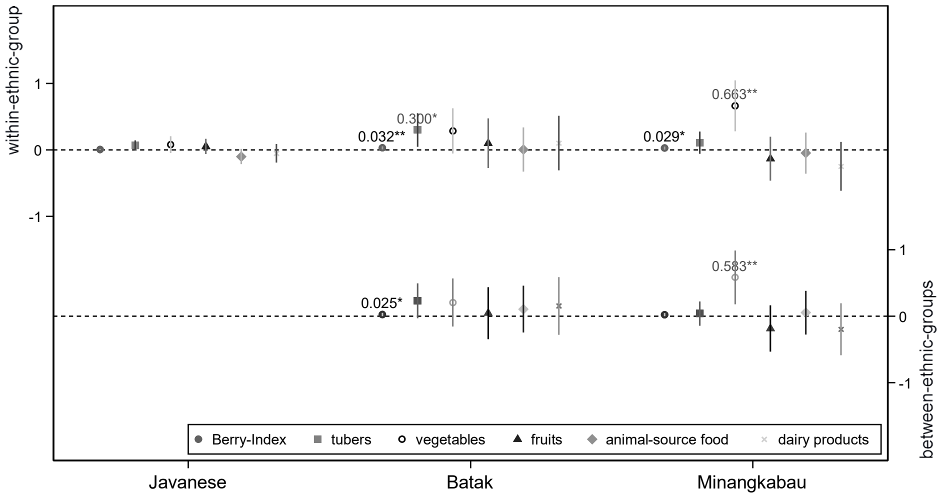
Figure 5.1 depicts predictive margins for cross-ethnic differences in dietary diversity, adjusted for sex_i, PCE_i, and control variables (see Tables A5.2 and A5.3). The main interest is to test H1: differences in dietary diversity by ethnic group (between-ethnic-groups). With Javanese children as the reference group, the difference in the Berry-Index score was less evident for the Batak but obvious for the Minangkabau (b = –0.031; p-val.<0.01). The adjusted predictive margins for food consumption frequency are similar to Table 5.1 except for the level-off consumption of dairy products (within-ethnic-group: Javanese=1.993; Batak=2.007; Minangkabau=1.918). The level-off consumption of dairy products may indicate a linkage between dairy products consumption and household SES. Figure 5.1 shows that Batak children consumed vegetables (b = 0.436; p-val.<0.01) and animal-source foods (b = 1.204; p-val. < 0.01) more often than the Javanese. However, compared to the Javanese, Batak children consumed fruits (b = –0.460; p-val.<0.01) less often, whereas Minangkabau children consumed tubers (b = –0.241; p-val.<0.01) and vegetables (b = –1.336; p-val.<0.01) less often.



Berry-Index score: 0–0.8; food consumption freq.: 0–7 day(s); CI 95%; * p<0.05; ** p<0.01
between-ethnic-groups: Javanese (ref.); complete predictive margins are in Table A4.3.

Figure 5.1. Cross-ethnic-group differences in dietary diversity

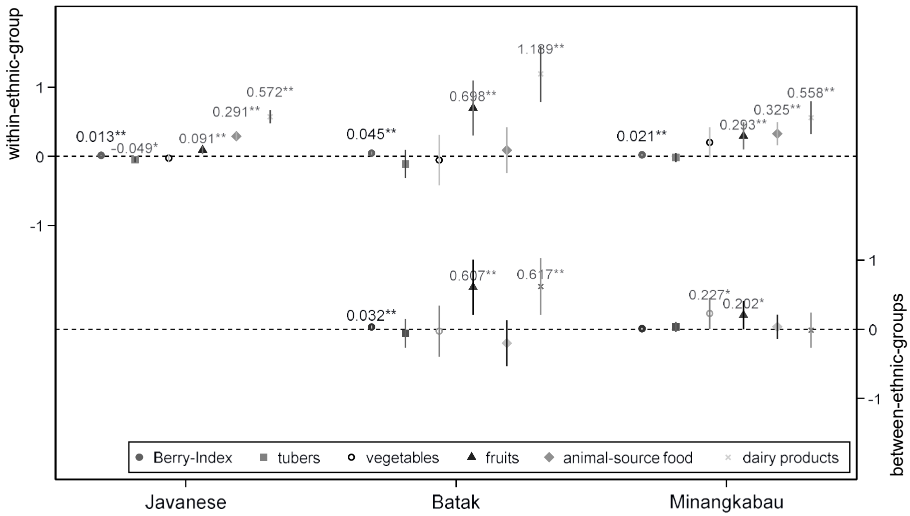
Figure 5.2 and Figure 5.3 show the test results for H2 and H3. Figure 5.2 shows adjusted marginal contrasts for cross-ethnic differences in dietary diversity by gender (see Table A5.4: *ethnic* × *sex*; and Table A5.5). The figure indicates that within-ethnic-group, gendered dietary diversity was absent for Javanese children, but not for the two other ethnic groups, as Batak and Minangkabau girls had a higher Berry-Index score than boys (Batak: b = 0.032; p-val.<0.01 and Minangkabau: b = 0.029; p-val.<0.05). Compared with boys of the same ethnic group, Batak girls consumed tubers (b = 0.300; p-val.<0.05) more often, whereas Minangkabau girls consumed vegetables (b = 0.663; p-val.<0.01) more often. These findings are worth mentioning because, although the absence of gender differences in dietary diversity within the ethnic group was as expected for the Javanese, the advantage in dietary diversity that both Batak and Minangkabau girls had was surprising considering the large contrast in their kinship systems, i.e., patrilineal Batak vs matrilineal Minangkabau. Within-ethnic-group differences at food group level showed that both Batak and Minangkabau girls consumed fruits and the pricier high-status animal-source foods and dairy products (p-val. ≥ 0.05) as often as boys. Comparison of between-ethnic-groups differences, with the Javanese as the reference, revealed that gender inequality remained significant for Batak children (Berry-Index: b = 0.025; p-val.<0.05), but less for the Minangkabau. Gendered vegetable consumption was higher among Minangkabau children than among the Javanese (between-ethnic-groups: b = 0.583; p-val.<0.01).



Berry-Index score: 0–0.8; food consumption freq.: 0–7 day(s); CI 95%; * p<0.05; ** p<0.01
within-ethnic-group: boys (ref.); between-ethnic-groups: Javanese (ref.); complete marginal contrasts are in Table A5.5.

Figure 5.2. Cross-ethnic-group differences in dietary diversity by gender

Figure 5.3 presents the marginal effects of PCE on cross-ethnic differences in dietary diversity (see Table A5.6: *ethnic* × *PCE*; and Table A5.7). The figure indicates that living in a higher-SES household is positively associated with better dietary diversity, regardless of ethnic group. However, the strength of these associations differs by ethnic group. Dietary diversity was very related to SES for Batak children, as they benefited the most from living in a higher-SES household (within-ethnic-group: b = 0.045; p-val.<0.01); this is significantly greater than for the Javanese (between-ethnic-groups: b = 0.032; p-val.<0.01). Overall, children from higher-SES households consumed fruits, animal-source foods, and dairy products more often than children from lower-SES households (e.g., Javanese: fruits: b = 0.091; p-val.<0.01; animal-source foods: b = 0.291; p-val.<0.01; dairy products: b = 0.572; p-val.< 0.01). Nevertheless, there were two exceptions: a) children from higher-SES Javanese households consumed tubers less often than poor Javanese children (b = –0.049; p-val.<0.05) and b) the frequency of consuming animal-source foods within Batak children did not vary by SES. It is important to note that the SES effects on fruits and dairy products consumption among Batak children were very high (within-ethnic-groups: fruits: b = 0.698; p-val.<0.01; dairy products: b = 1.189; p-val.<0.01). The large SES effect among Batak children means that lower-SES Batak children consumed fruits and dairy products considerably less often than children from higher-SES Batak households did.



Berry-Index score: 0–0.8; food consumption freq.: 0–7 day(s); CI 95%; * p<0.05; ** p<0.01
between-ethnic-groups: Javanese (ref.); complete marginal effects are in Table A5.7.

Figure 5.3. Cross-ethnic-group marginal effects of PCE on dietary diversity

5.6 Discussion

Our study offers new evidence on how dietary diversity differs by ethnic group. Using data from Indonesia, we explored not only whether kinship systems may explain differences in dietary diversity across ethnic groups, but also whether gender inequality and household SES play a role in ethnic-related dietary diversity. Furthermore, we considered food culture.

Our results showed three important clusters of findings. First, we found that dietary diversity differed by ethnic group (H1). Javanese children scored higher in dietary diversity than the other two ethnic groups, particularly in comparison to the Minangkabau. This means that Javanese children had a higher dietary diversity among the three ethnic groups of interest. The fact that ethnic group differences in dietary diversity remain significant even after adjusting for some potential confounders suggests that ethnicity is an exogenous explanatory variable for dietary diversity.

Second, we found ethnic-related gender inequality in dietary diversity. However, the evidence indicated the opposite to the gender inequality hypothesised in H2. The results indicated that Batak and Minangkabau boys consumed less variety in foods than girls. This gendered dietary diversity was absent among children of the bilateral Javanese. When food consumption frequencies were considered, Batak and Minangkabau girls and boys consumed fruits and the pricier high-status foods (e.g., animal-source foods and dairy products) as often as each other, but boys consumed low-status foods less often: tubers for Batak boys and vegetables for Minangkabau boys. Such evidence of girls being better-off in terms of dietary diversity in two contrasting kinship systems (patrilineal Batak vs matrilineal Minangkabau) unveils interesting, unexpected associations of gendered dietary diversity and kinship systems. Perhaps the explanation for these findings lies in how both unilineal ethnic groups construct the gender relation in everyday life. The high status of men characterises the patrilineal Batak ethnic group (Rodenburg 2013), but none of the previous studies designated the matrilineal Minangkabau as a matriarchal society (Fernandez & Kambhampati 2017; Blackwood 2000; van Reenen 2013). In fact, most of the Minangkabau are Muslims, where men dominate in the public domain and in leadership positions (Blackwood 2000; van Reenen 2013). The Minangkabau also have a long-standing tradition of male outmigration (Hugo 2015; Ananta et al. 2015), where returning successful male migrants receive high social status. Economic development and the nation's egalitarian gender norms may have helped Batak and Minangkabau girls to have equal access to the pricier, higher-status foods in the same way as boys. However, the men's high status among Batak people in multiple domains of life and among Minangkabau people in at least the public domain and in religious leadership might have caused boys to be less inclined to consume low-status foods, and this might cause their diet to be less varied than that of girls.

Third, we found that the effects of household SES on dietary diversity differed by ethnic group (H3). Although living in a higher-SES household benefited children's dietary diversity regardless of their ethnic group, the effect was considerably greater for Batak children than for the Javanese and the Minangkabau. In general, children from higher-SES households consumed fruits, animal-source foods, and dairy products more often; these foods are pricier than tubers and vegetables. However, for Batak children, there were no such SES differentials for animal-source foods consumption. Because Batak's diet relies more on the pricier animal-source foods (Simatupang & Simatupang 2016; Siahaan 1993), lower-SES Batak households might be left with limited financial resources to diversify their children's diet. This was well reflected in their children's considerably less often consumption of fruits and dairy products compared to Batak children of higher-SES backgrounds and may cause dietary diversity of lower-SES Batak children at risk. We also found that children from higher-SES Javanese households consumed tubers less often. Some studies have suggested that the Javanese perceive cassava, which can be classified as a tuber, as a symbol of poverty (van Der Eng 1998). Such negative food stigmas may explain the low tuber consumption among well-off Javanese children.

This study advances previous literature in several ways. First, we have shown the importance of ethnicity as a determinant of dietary diversity. Previous studies have reported differences in dietary diversity consequent to food supply factors such as residential location and seasonality (Gregory et al. 2005; Spencer et al. 2017). We have demonstrated that the association between ethnic group and dietary diversity remains significant even after controlling for these factors. The effects of other confounders, however, might still remain, for example, if the child is vegetarian and for unreported food stigmas.

Second, we found that the association between gender inequality and dietary diversity in Indonesia differed from that of other, usually patrilineal, South Asian societies (Bose 2011; Madjdian & Bras 2016; Gittelsohn et al. 1997; Das Gupta 1987). Many studies in South Asia have documented various forms of discrimination against girls and women in terms of food allocation and nutritional status. The Indonesian context is different. Indonesian girls, including those from the patrilineal Batak, seemed to have equal access to different food groups in similar ways to boys, including for the pricier high-status foods. The gender inequality in dietary diversity in Indonesia was actually reversed, as Batak and Minangkabau boys consumed low-status foods less often, and this was to their detriment.

Third, this study has reaffirmed the significant associations of household SES to food access and food choice reported in a number of studies (van Der Eng 1998; Darmon & Drewnowski 2008; Turrell et al. 2003; den Hartog et al. 2006). We examined the associations further and showed that the effects of household SES on dietary diversity varied by ethnic group. Although further research is required, such differences probably result from food culture related to how households from different ethnic group backgrounds and a specific social class spend their resources on food. In this study, we found that lower-SES Batak children consumed fruits and dairy products less often, most likely to enable them to consume animal-source foods more often. We also found that, probably due to the negative food stigma of cassava, the better-off Javanese children consumed tubers, into which cassava can be classified, less often.

Some limitations apply to this study. First, the Berry-Index score that we used was not validated against nutrient adequacy because data on the portion size of foods that children consumed were not available in IFLS. The index that we used consisted of fewer food groups (e.g. our study vs Katanoda et al. (2006): 5 food groups vs 16 food groups); this might greatly reduce its sensitivity for measuring differences in dietary diversity. Also, it was based on a 7-day reference period, where measurement errors due to recall bias may affect the data quality. Moreover, unlike the FAO's Dietary Diversity Score (Kennedy et al. 2011) and the WHO's Minimum Dietary Diversity (Jones et al. 2014) that have been used in many studies, the index that we used has never been tested in a context other than the current study. Furthermore, assessing the dietary diversity of school-aged children is particularly challenging, because they might consume foods that may not be reported in household surveys but that could still affect their dietary diversity (e.g., consuming food from the school canteen or street food vendors). These limitations call for future studies aimed at improving the Berry-Index score by collecting data on the portion size of foods that children consumed, a larger number of food groups, a shorter reference period (e.g., 24-hours recall or 3-day reference period), different contexts, and cautious measures of foods consumed during school hours.

Second, the current study did not assess the moderating effects of ethnic group on the linkage between dietary diversity and nutritional status. We instead focused on issues relating to kinship systems, gender inequality, and effects of household SES on the dietary diversity of different ethnic groups. Our approach offered insights on the mechanisms relating to ethnic-related dietary diversity. Future studies could further extend our work by analysing simultaneous evidence on the linkages between ethnic group and nutritional status.

Third, we tentatively suggested that gender inequality in dietary diversity was a result of the higher status of males and occurred even in the matrilineal Minangkabau. Fernandez & Kambhampati (2017) have shown that inequality in spousal bargaining power may cause gender inequality in child education expenditure in Indonesia. Taking Fernandez & Kambhampati (2017) as an example, further studies could analyse spousal bargaining power as a novel measure for gender relations in each ethnic group and test the associations of such a measure with various life outcomes, including dietary diversity and nutritional status.

Given our results, stakeholders and policymakers in Indonesia could establish initiatives to improve children's dietary diversity, particularly for school-aged boys. Boys should be encouraged to consume a wide variety of foods, including the perceived low-status foods (e.g., tubers and vegetables) more often. Further action is also required to reduce SES-related differences in dietary diversity. Educational programmes, for example, could be instigated to teach children not to rely mainly on the pricier food types (e.g., animal-source foods) but to diversify their diets. In the Indonesian context, such programmes should be on government nutrition scale-up agendas targeting Batak households with lower-SES backgrounds.

Supplementary Material

Table A5.1. Association between Berry-Index and nutritional status

		height-for-age Z-scores		BMI-for-age Z-scores	
		Coef.	SE	Coef.	SE
dietary diversity score		0.253	(0.098)*	-0.045	(0.114)
sex	boys	ref.		ref.	
	girls	0.061	(0.026)*	0.009	(0.032)
age (in years)		-0.011	(0.007)	-0.003	(0.010)
sibling size		-0.115	(0.018)**	-0.061	(0.018)**
mother's education (in years)		0.015	(0.004)**	0.016	(0.005)**
real PCE (in million Rupiah)		0.164	(0.018)**	0.168	(0.022)**
residential area	urban	ref.		ref.	
	rural	-0.318	(0.031)**	-0.079	(0.038)*
island	Java & Bali	ref.		ref.	
	outside Java & Bali	-0.098	(0.033)**	0.107	(0.039)**
seasons	dry season	ref.		ref.	
	rainy season	-0.010	(0.025)	0.014	(0.032)
IFLS wave	IFLS-3 (2000)	ref.		ref.	
	IFLS-4 (2007/2008)	0.115	(0.034)**	0.156	(0.040)**
	IFLS-5 (2014/2015)	0.350	(0.039)**	0.322	(0.046)**
constant		-1.469	(0.110)**	-0.836	(0.134)**
R^2		0.139		0.054	
R^2-adj		0.136		0.051	

* $p<0.05$; ** $p<0.01$
N of children=6,368; N of mothers=3,833
Birth order dummies were included in the models but are not presented to reduce the table size. Cluster-robust standard error at mother level in parentheses. The WHO growth standards were used to calculated height-for-age Z-scores and BMI-for-age Z-scores.

Table A5.2. Ethnic group differences in dietary diversity (Model 1)

		Berry-Index		tubers		vegetables		fruits		animal-source		dairy products	
		Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
ethnic group	Javanese	ref.		ref.		ref.		ref.		ref.		ref.	
	Batak	-0.017	(0.009)	-0.081	(0.093)	0.436	(0.141)**	-0.460	(0.132)**	1.204	(0.137)**	0.014	(0.156)
	Minangkabau	-0.031	(0.008)**	-0.241	(0.067)**	-1.336	(0.137)**	-0.037	(0.119)	-0.120	(0.121)	-0.075	(0.144)
sex	boys	ref.		ref.		ref.		ref.		ref.		ref.	
	girls	0.011	(0.004)**	0.094	(0.034)**	0.161	(0.058)**	0.037	(0.054)	-0.085	(0.052)	-0.058	(0.063)
real PCE (in million Rupiah)		0.015	(0.002)**	-0.047	(0.018)*	-0.003	(0.031)	0.127	(0.031)**	0.289	(0.030)**	0.586	(0.047)**
age (in years)		-0.002	(0.001)*	-0.009	(0.010)	0.031	(0.017)	-0.035	(0.015)*	-0.069	(0.015)**	-0.168	(0.018)**
mother's education (in years)		0.003	(0.001)**	-0.001	(0.006)	0.023	(0.009)**	0.003	(0.008)	0.023	(0.008)**	0.083	(0.010)**
sibling size		0.003	(0.002)	0.090	(0.030)**	0.063	(0.036)	0.046	(0.035)	0.024	(0.036)	-0.126	(0.039)**
residential area	urban	ref.		ref.		ref.		ref.		ref.		ref.	
	rural	-0.007	(0.004)	0.217	(0.041)**	0.186	(0.069)**	0.186	(0.065)**	-0.208	(0.064)**	-0.630	(0.077)**
	Java-Bali	ref.		ref.		ref.		ref.		ref.		ref.	
	outside Java-Bali	-0.002	(0.006)	-0.005	(0.057)	0.474	(0.085)**	-0.113	(0.082)	0.344	(0.086)**	-0.200	(0.099)*
seasonality	dry season	ref.		ref.		ref.		ref.		ref.		ref.	
	rainy season	0.006	(0.004)	0.009	(0.035)	0.009	(0.059)	0.015	(0.054)	0.058	(0.053)	0.087	(0.064)
IFLS wave	IFLS-3 (2000)	ref.		ref.		ref.		ref.		ref.		ref.	
	IFLS-4 (2007/2008)	0.008	(0.004)	0.103	(0.056)	-0.786	(0.077)**	-0.567	(0.078)**	0.111	(0.074)	0.228	(0.088)**
	IFLS-5 (2014/2015)	-0.097	(0.006)**	-0.485	(0.054)**	-2.536	(0.088)**	-1.236	(0.084)**	-0.233	(0.083)**	-0.274	(0.095)**
constant		0.621	(0.012)**	0.749	(0.124)**	4.623	(0.209)**	3.048	(0.188)**	4.356	(0.187)**	3.181	(0.240)**
R^2		0.110		0.065		0.206		0.065		0.071		0.149	
R^2-adj		0.107		0.061		0.203		0.062		0.068		0.146	

* $p<0.05$; ** $p<0.01$

N of children = 6,478; N of mothers = 3,878

Birth order dummies were included in the models but are not presented to reduce the table size. Cluster-robust standard error at mother level in parentheses.

Table A5.3. Predictive margins of dietary diversity differed by ethnic group

	Javanese		Batak		Minangkabau	
	margin	SE	margin	SE	margin	SE
within-ethnic-group:						
Berry-Index	0.614	(0.002)**	0.597	(0.009)**	0.583	(0.008)**
tubers	0.863	(0.025)**	0.782	(0.085)**	0.622	(0.057)**
vegetables	4.437	(0.037)**	4.873	(0.131)**	3.100	(0.128)**
fruits	2.402	(0.036)**	1.942	(0.120)**	2.365	(0.109)**
animal-source foods	4.227	(0.037)**	5.431	(0.125)**	4.108	(0.109)**
dairy products	1.993	(0.043)**	2.007	(0.144)**	1.918	(0.130)**
between-ethnic-groups:						
Berry-Index			-0.017	(0.009)	-0.031	(0.008)**
tubers			-0.081	(0.093)	-0.241	(0.067)**
vegetables			0.436	(0.141)**	-1.336	(0.137)**
fruits			-0.460	(0.132)**	-0.037	(0.119)
animal-source foods			1.204	(0.137)**	-0.120	(0.121)
dairy products			0.014	(0.156)	-0.075	(0.144)

* p<0.05; ** p<0.01
Berry-Index: 0–0.8. Food consumption freq.: 0–7 day(s). Predictive margins are from Model 1. Cluster-robust standard errors at mother level in parentheses. For between-ethnic-groups differences: Javanese children (ref.).

Table A5.4. Ethnic group differences in dietary diversity by gender (Model 2)

		Berry-Index		tubers		vegetables		fruits		animal-source		dairy products	
		Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
ethnic group	Javanese	ref.		ref.		ref.		ref.		ref.		ref.	
	Batak	-0.028	(0.012)*	-0.184	(0.101)	0.343	(0.163)*	-0.480	(0.151)**	1.156	(0.157)**	-0.054	(0.185)
	Minangkabau	-0.041	(0.011)**	-0.259	(0.078)**	-1.593	(0.163)**	0.045	(0.149)	-0.143	(0.145)	0.011	(0.171)
ethnic group × girls	Javanese	ref.		ref.		ref.		ref.		ref.		ref.	
	Batak	0.025	(0.013)*	0.231	(0.134)	0.205	(0.185)	0.047	(0.199)	0.106	(0.180)	0.154	(0.221)
	Minangkabau	0.023	(0.012)	0.040	(0.093)	0.583	(0.205)**	-0.185	(0.178)	0.054	(0.168)	-0.196	(0.200)
sex	boys	ref.		ref.		ref.		ref.		ref.		ref.	
	girls	0.007	(0.004)	0.069	(0.039)	0.079	(0.064)	0.053	(0.059)	-0.100	(0.058)	-0.051	(0.071)
PCE (in million Rupiah)		0.015	(0.002)**	-0.047	(0.018)*	-0.003	(0.032)	0.127	(0.031)**	0.289	(0.030)**	0.586	(0.047)**
age (in years)		-0.002	(0.001)*	-0.009	(0.010)	0.030	(0.017)	-0.034	(0.015)*	-0.069	(0.015)**	-0.168	(0.018)**
mother's education (in years)		0.003	(0.001)**	-0.001	(0.006)	0.022	(0.009)**	0.003	(0.008)	0.023	(0.008)**	0.084	(0.010)**
sibling size		0.003	(0.002)	0.088	(0.030)**	0.062	(0.036)	0.045	(0.035)	0.023	(0.036)	-0.128	(0.039)**
residential area	urban	ref.		ref.		ref.		ref.		ref.		ref.	
	rural	-0.007	(0.004)	0.216	(0.041)**	0.184	(0.069)**	0.186	(0.065)**	-0.208	(0.064)**	-0.630	(0.077)**
	Java-Bali	ref.		ref.		ref.		ref.		ref.		ref.	
	outside Java-Bali	-0.002	(0.006)	-0.005	(0.057)	0.476	(0.085)**	-0.114	(0.082)	0.344	(0.086)**	-0.201	(0.099)*
seasonality	dry season	ref.		ref.		ref.		ref.		ref.		ref.	
	rainy season	0.006	(0.004)	0.008	(0.036)	0.006	(0.059)	0.016	(0.054)	0.058	(0.053)	0.087	(0.064)
IFLS wave	IFLS-3 (2000)	ref.		ref.		ref.		ref.		ref.		ref.	
	IFLS-4 (2007/2008)	0.008	(0.004)	0.102	(0.056)	-0.787	(0.077)**	-0.568	(0.078)**	0.110	(0.074)	0.227	(0.088)*
	IFLS-5 (2014/2015)	-0.098	(0.006)**	-0.487	(0.054)**	-2.539	(0.088)**	-1.236	(0.084)**	-0.234	(0.083)**	-0.275	(0.095)**
constant		0.624	(0.012)**	0.763	(0.125)**	4.676	(0.211)**	3.037	(0.189)**	4.365	(0.188)**	3.174	(0.242)**
R^2		0.111		0.065		0.207		0.065		0.071		0.149	
R^2-adj		0.108		0.062		0.204		0.062		0.068		0.146	

* p<0.05; ** p<0.01
N of children = 6,478; N of mothers = 3,878
Birth order dummies were included in the models but are not presented to reduce the table size. Cluster-robust standard error at mother level in parentheses.

Table A5.5. Predictive marginal contrasts of dietary diversity differed by ethnic group × sex

	Javanese		Batak		Minangkabau	
	margin	SE	margin	SE	margin	SE
within-ethnic-group:						
Berry-Index	0.007	(0.004)	0.032	(0.012)**	0.029	(0.012)*
tubers	0.069	(0.039)	0.300	(0.128)*	0.109	(0.085)
vegetables	0.079	(0.064)	0.285	(0.173)	0.663	(0.195)**
fruits	0.053	(0.059)	0.100	(0.191)	-0.132	(0.168)
animal-source foods	-0.100	(0.058)	0.006	(0.170)	-0.047	(0.157)
dairy products	-0.051	(0.071)	0.104	(0.209)	-0.247	(0.187)
between-ethnic-groups:						
Berry-Index			0.025	(0.013)*	0.023	(0.012)
tubers			0.231	(0.134)	0.040	(0.093)
vegetables			0.205	(0.185)	0.583	(0.205)**
fruits			0.047	(0.199)	-0.185	(0.178)
animal-source foods			0.106	(0.180)	0.054	(0.168)
dairy products			0.154	(0.221)	-0.196	(0.200)

* p<0.05; ** p<0.01
Berry-Index: 0–0.8. Food consumption freq.: 0–7 day(s). Predictive marginal contrast is from Model 2. Cluster-robust standard errors at mother level in parentheses. For within-ethnic-group differences: boys (ref.); between-ethnic-groups differences: Javanese children (ref.).

Table A5.6. Ethnic group differences in dietary diversity by PCE (Model 3)

		Berry-Index		tubers		vegetables		fruits		animal-source		dairy products	
		Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
ethnic group	Javanese	ref.		ref.		ref.		ref.		ref.		ref.	
	Batak	-0.047	(0.014)**	-0.025	(0.153)	0.458	(0.230)*	-1.039	(0.217)**	1.394	(0.232)**	-0.570	(0.207)**
	Minangkabau	-0.041	(0.013)**	-0.282	(0.087)**	-1.621	(0.193)**	-0.294	(0.173)	-0.162	(0.170)	-0.061	(0.201)
ethnic group × PCE	Javanese	ref.		ref.		ref.		ref.		ref.		ref.	
	Batak	0.032	(0.011)**	-0.060	(0.105)	-0.029	(0.188)	0.607	(0.204)**	-0.202	(0.170)	0.617	(0.209)**
	Minangkabau	0.008	(0.006)	0.033	(0.038)	0.227	(0.116)*	0.202	(0.103)*	0.035	(0.090)	-0.014	(0.129)
sex	boys	ref.		ref.		ref.		ref.		ref.		ref.	
	girls	0.011	(0.004)**	0.094	(0.034)**	0.160	(0.058)**	0.038	(0.054)	-0.086	(0.052)	-0.057	(0.063)
PCE (in million Rupiah)		0.013	(0.002)**	-0.049	(0.020)*	-0.027	(0.032)	0.091	(0.031)**	0.291	(0.032)**	0.572	(0.050)**
age (in years)		-0.002	(0.001)*	-0.009	(0.010)	0.031	(0.017)	-0.035	(0.015)*	-0.069	(0.015)**	-0.169	(0.018)**
mother's education (in years)		0.003	(0.001)**	-0.001	(0.006)	0.022	(0.009)**	0.002	(0.008)	0.023	(0.008)**	0.083	(0.010)**
sibling size		0.004	(0.002)	0.089	(0.030)**	0.061	(0.036)	0.056	(0.035)	0.020	(0.036)	-0.114	(0.039)**
residential area	urban	ref.		ref.		ref.		ref.		ref.		ref.	
	rural	-0.006	(0.004)	0.215	(0.042)**	0.186	(0.069)**	0.201	(0.064)**	-0.213	(0.064)**	-0.615	(0.077)**
	Java-Bali	ref.		ref.		ref.		ref.		ref.		ref.	
	outside Java-Bali	-0.001	(0.006)	-0.005	(0.057)	0.476	(0.085)**	-0.110	(0.082)	0.344	(0.086)**	-0.198	(0.099)*
seasonality	dry season	ref.		ref.		ref.		ref.		ref.		ref.	
	rainy season	0.006	(0.004)	0.009	(0.036)	0.013	(0.059)	0.024	(0.054)	0.057	(0.053)	0.092	(0.064)
IFLS wave	IFLS-3 (2000)	ref.		ref.		ref.		ref.		ref.		ref.	
	IFLS-4 (2007/2008)	0.008	(0.004)	0.104	(0.056)	-0.785	(0.077)**	-0.570	(0.078)**	0.112	(0.074)	0.224	(0.088)*
	IFLS-5 (2014/2015)	-0.097	(0.006)**	-0.485	(0.054)**	-2.532	(0.088)**	-1.230	(0.083)**	-0.233	(0.083)**	-0.272	(0.095)**
constant		0.622	(0.012)**	0.755	(0.125)**	4.655	(0.210)**	3.063	(0.187)**	4.365	(0.187)**	3.167	(0.240)**
R^2		0.112		0.065		0.207		0.068		0.072		0.151	
R^2-adj		0.109		0.061		0.204		0.065		0.068		0.148	

* p<0.05; ** p<0.01
N of children = 6,478; N of mothers = 3,878
Birth order dummies were included in the models but are not presented to reduce the table size. Cluster-robust standard error at mother level in parentheses.

Table A5.7. Predictive marginal effects of dietary diversity differed by ethnic group × PCE

	Javanese		Batak		Minangkabau	
	margin	SE	margin	SE	margin	SE
within-ethnic-group:						
Berry-Index	0.013	(0.002)**	0.045	(0.011)**	0.021	(0.006)**
tubers	-0.049	(0.020)*	-0.109	(0.104)	-0.016	(0.034)
vegetables	-0.027	(0.032)	-0.055	(0.186)	0.201	(0.112)
fruits	0.091	(0.031)**	0.698	(0.203)**	0.293	(0.100)**
animal-source foods	0.291	(0.032)**	0.089	(0.168)	0.325	(0.085)**
dairy products	0.572	(0.050)**	1.189	(0.206)**	0.558	(0.121)**
between-ethnic-groups:						
Berry-Index			0.032	(0.011)**	0.008	(0.006)
tubers			-0.060	(0.105)	0.033	(0.038)
vegetables			-0.029	(0.188)	0.227	(0.116)*
fruits			0.607	(0.204)**	0.202	(0.103)*
animal-source foods			-0.202	(0.170)	0.035	(0.090)
dairy products			0.617	(0.209)**	-0.014	(0.129)

* $p<0.05$; ** $p<0.01$

Berry-Index: 0–0.8. Food consumption freq.: 0–7 day(s). Predictive marginal effects of PCE are from Model 3. Cluster-robust standard errors at mother level in parentheses. For between-ethnic-groups differences: Javanese children (ref.).

Chapter 6

General Discussion

6.1. Summary of findings

This thesis is based on the idea that the nutritional status of children and adolescents is inseparable from the sociocultural context in which they live. By placing more focus on sociocultural factors, this thesis aimed to examine how gender, religion, and ethnicity influenced the nutritional status of children and adolescents (0–19 years of age) in Indonesia. Four empirical chapters have been produced to answer specific research questions related to the main objective. The findings can now be summarised as follows.

Chapter 2 analysed the first research question (RQ1): "What is the influence of women's empowerment on adolescent nutritional status (10–19 years of age)?". The chapter found a significant positive association between the mother's education and adolescent HAZ. However, such a positive association was not the case for other indicators of women's empowerment. Regarding mother's working status, it was shown that adolescents of blue-collar mothers had a lower nutritional status compared to adolescents of mothers who were housewives. With control for variability in financial resources between households in place (via PCE or Personal Consumption Expenditure), it left the long and typically less flexible working hours of women working in blue-collar jobs as a probable cause. The lower nutritional status was probably the result of limited time that blue-collar mothers could spend in supervising the dietary intake of their adolescents. No influence of mother's bargaining power on adolescent nutritional status was found. The fact that the effect on HAZ—a long-run indicator of nutritional status—was significant, but not on BAZ—a more short-term indicator of nutritional status—signals that the problem might have started early in life, well before adolescence. Chapter 2 also examined gender inequality in adolescent nutritional status. Indonesian adolescent boys had on average, a lower BAZ than girls. The number of years that the mother spent in school seemed to reduce boys' lack in BAZ. However, further (exploratory) analyses on food consumption indicated that an unhealthy compensating mechanism might be at work. The chapter showed that the frequency of fast foods consumption of boys increased with the number of years the mother had spent in school. These boys of educated mothers also had a slightly more frequent consumption of instant noodles than girls. It might indicate gender bias in new disguise, particularly if it happened because educated mothers were more permissive with boys than with girls in terms of dietary choices.

Chapter 3 examined the role of women's empowerment, specifically the mother's education, in relation to overweight. The chapter attempted to answer the second research question (RQ2): "What is the role of the mother's education in the risk of overweight of children and adolescents and in influencing potential inequalities in overweight within sibling sets (e.g., by gender, birth order, and number of siblings)?". It was observed that the eldest, and the youngest siblings, as well as children and adolescents from smaller families were more likely to be overweight. In contrast to results from developed countries (Madden 2017; Ruiz et al. 2016; Apouey & Geoffard 2016), the findings suggested that in Indonesia, children and adolescents of educated mothers had a higher odds of overweight, confirming the study of Ekawidyani et al. (2018) on overweight among school-aged children of educated mothers in Bogor–Indonesia. It was proposed that the effects of mother's education on overweight may differ according to context, i.e., developed vs developing countries. Previous studies have suggested that educated mothers are more open to new diets and nutrition innovations (Smith et al. 2003). Such openness perhaps corresponds to a specific stage in the global nutrition transition (Popkin 2013). Many developing countries, including Indonesia, are still in the fourth stage of the global nutrition transition. The openness, therefore, might take its form in adoption of a high-calorie diet and a sedentary lifestyle, rather than in the adoption of a healthy diet and active lifestyle, which is the characteristic of the fifth stage of the Global Nutrition Transition. Chapter 3 found that the effects of mother's education on overweight were higher for boys and the eldest. Further analyses showed that sons of educated mothers consumed more often high-calorie foods than did their daughters. The gender gap in consumption of high-calorie foods became greater from late childhood onwards (5–19 years of age).

In Chapters 4 and 5, the focus shifted to how religious and ethnic cultural practices influenced the nutritional status of Indonesian children and adolescents. In Chapter 4, the following research question was central: "Does maternal Ramadan fasting influence nutritional status in childhood and adolescence?". It was found that prenatal exposure to Ramadan did influence the stature of Indonesian children and adolescents. Children and adolescents of religious Muslim mothers who were prenatally exposed to Ramadan were shorter in stature than their unexposed siblings. This shorter stature developed over time and depended on the timing of the exposure. Children who were prenatally exposed to Ramadan in the first trimester of the mother's pregnancy had a shorter stature, i.e. a lower HAZ, in late adolescence (15–19 years of age). They were also thinner, as shown in a lower BAZ, in early adolescence (10–14 years of age) if the exposure took place in the third trimester of the pregnancy. Chapter 4 suggested that the main cause of the negative effects of prenatal exposure to Ramadan is likely maternal Ramadan fasting. This is because both religious and less-religious Muslim groups shared exactly the same experiences in socioeconomic and health factors during Ramadan, except for differences in the extent of maternal fasting. The share of maternal fasting was higher among the religious pregnant Muslim women compared to that of less-religious pregnant Muslim women. Besides these results, two other surprising findings emerged. First, children and adolescents of less-religious Muslim mothers possibly benefited from prenatal exposure to Ramadan. This was shown in the positive effects on BAZ, which peaked in early adolescence (10–14 years of age). Second, there was evidence of negative effects of prenatal exposure to Ramadan on HAZ for those who were born to non-Muslim mothers. Different to what children and adolescents of religious Muslim mothers experienced, the negative effects occurred only in early childhood (0–4 years of age) but not in later life stages. These interesting findings were discussed in the light of Indonesia's context, including food price spikes during Ramadan and the timing of the annual bonuses or *Tunjangan Hari Raya* (THR).

Chapter 5 examined the fourth research question (RQ4): "What is the influence of ethnicity on children's nutrition and how does this influence differ by gender and household SES?". The chapter specifically looked at dietary diversity of school-aged children (7–12 years of age) among family systems that differed between the ethnic groups of bilateral Javanese, patrilineal Batak, and the matrilineal Minangkabau. Results showed that dietary patterns strongly differed by ethnic group. Most notably is the significantly higher consumption of animal-source foods by Batak school-aged children compared to the other two ethnic groups. A gendered dietary pattern in the two unilineal ethnic groups—the patrilineal Batak and the traditionally matrilineal Minangkabau—was observed. Surprisingly, the results showed that Batak and Minangkabau girls had a higher dietary diversity than boys. In the two unilineal ethnic groups, girls consumed animal-source foods and dairy products as often as boys did, but boys consumed less often than girls the cheaper and possibly perceived as lower-status foods (i.e., tubers in the case of Batak boys and vegetables in the case of Minangkabau boys). Chapter 5 also showed that school-aged children with higher SES backgrounds had a higher dietary diversity than those with lower SES backgrounds, regardless of ethnic group. Better-off Javanese school-aged children consumed less often tubers, a food group that includes cassava. This likely demonstrates the negative food stigma of cassava as food for the poor among those living in Java (van Der Eng 1998). A worrisome dietary pattern of low dietary diversity occurred in Batak school-aged children with lower SES background. These children consumed animal-source foods as often as those with higher SES, but at the expense of consuming fruits and dairy products less often. This SES-related dietary pattern among Batak school-aged children is in line with the Batak food preferences, in which animal-source foods are central. Finally, it was also shown that dietary diversity positively correlated with nutritional status, reaffirming findings of previous studies (Arimond & Ruel 2004; Hatløy et al. 2000; Nithya & Bhavani 2016).

6.2. Filling in the knowledge gaps

Each empirical chapter of this thesis has thoroughly discussed its findings in response to the specific research questions. Therefore, this section focuses more on synthesizing these findings to fill in three knowledge gaps mentioned in Section 1.1. These are: 1) the underlying reason for the emergence of malnourished adolescent boys in South Asia and Southeast Asia; 2) how religious and ethnic-related cultural practices affect the nutritional status of children and adolescents; and 3) the role of women's empowerment in the nutritional status of children and adolescents and the gender inequalities therein.

On the first knowledge gap, previous studies have argued that in the predominantly patrilineal-patrilocal South Asia, son preference was probably the main reason behind gender inequality in nutritional status (Bose 2011; Khatun et al. 2004; Dasgupta 2016; Das Gupta 1987; Jayachandran & Pande 2017). These studies suggested that there has been gender bias in food access against young girls. South Asian girls of under-five and of school-age were often reported to have very limited access to nutrient-rich foods (e.g., animal-source foods and dairy products) and were thus more often malnourished than boys of the same age. As what has been stated before, this may explain the phenomenon of malnourished girls in the region. However, the same explanation would not stand for the phenomenon of malnourished adolescent boys in the WHO report (WHO 2006a) "Adolescent nutrition: a review of the situation in selected South-East Asian countries". The report showed that in certain South Asian and Southeast Asian countries, boys were more likely to be malnourished than girls, especially in adolescence. This may well indicate that in regions where son preference prevails, adolescent boys did not necessarily have a better nutritional status than girls. To what extent do the findings from the empirical chapters of this thesis illuminate this phenomenon further?

In general, Indonesia has egalitarian gender norms. Therefore, it is reasonable to expect gender equality in nutritional status. This was however not the case when considering the findings of this thesis. Mirroring the aforementioned phenomenon of malnourished adolescent boys in the WHO report (WHO 2006a), Chapter 2 revealed that Indonesian adolescent boys had on average a lower nutritional status than girls. Why did this happen in the supposed egalitarian Indonesia? Chapter 5 might offer a partial explanation to this. The chapter inferred that the generally egalitarian gender norms in Indonesia may have improved (school-aged) girls' access to nutrient-rich foods. Chapter 5 found that there were no gender differences in consumption of animal-source foods and dairy products among the three ethnic groups studied. However, it seemed that among ethnic groups with a unilineal kinship system, i.e., the Batak and Minangkabau, where gender differences are supposed to be stronger, boys differed in their food consumption to girls. They consumed less often the cheaper but healthy "lower-status foods" than girls (e.g., vegetables and tubers). Such dietary patterns may lower boys' dietary diversity and could be one reason why they were more vulnerable to malnutrition than girls. Perhaps the same mechanism also applies to other countries in South Asia and Southeast Asia.

Regarding the second knowledge gap, Omigbodun et al. (2010) and others (Assefa et al. 2015; Khongsdier & Mukherjee 2003) have proposed that cultural practices related to religious and ethnic groups could influence child nutritional status. These previous works, however, did not specify what these specific cultural practices are and how it may affect nutritional status. Chapter 4–5 attempted to remedy this knowledge gap. The two chapters focused on specific cultural practices connected to the dietary habits and food intake of religious and ethnic groups in Indonesia.

The first cultural practice is maternal Ramadan fasting. The thesis examined how observance of Ramadan fasting among pregnant Muslim women influenced maternal dietary intake and thereby affected the nutritional status of the unborn in later life stages. In defining a person's life outcomes—in this thesis, the nutritional status—, the prenatal phase has its own importance, which is not less than after-birth life stages, as the medical literature agrees (Harding 2001; Langley-Evans 2014). Meanwhile, most interpretations of Islam allow pregnant Muslim mothers not to fast during Ramadan (Trepanowski & Bloomer 2010), particularly if the health of the mother and the unborn is at risk. Surprisingly, for various reasons, previous studies have indicated that many pregnant Muslim mothers attempted to fast for at least one day during Ramadan (Bilsen et al. 2016; Joosoph et al. 2004; Mirghani et al. 2003; Mubeen et al. 2012; Robinson & Raisler 2005). Is such restrictive maternal dietary intake safe for the unborn? Section 6.1 summarised that the negative effects of maternal Ramadan fasting on nutritional status were not apparent in early life stages. Only later in late adolescence (15–19 years of age), were the effects of prenatal exposure to Ramadan found in HAZ of those who were born to religious Muslim mothers. One might argue that although the compromised HAZ in Chapter 4 is statistically significant, the difference between those who were exposed in comparison to their unexposed siblings was rather small. Nevertheless, many studies have shown that HAZ, an indicator of nutritional status, is associated with other life outcomes, including self-esteem (Sohn 2016), cognitive ability (Sánchez 2017), and labour market performance (Bargain & Zeidan 2016). Lagging behind on these life outcomes may not only negatively affect individual well-being but could also put the social and economic progress of a society on hold. Therefore, it is important that any cause of yet the smallest reduction in nutritional status should not be overlooked.

The second cultural practice is ethnic food preferences. This thesis considered two cases: the negative food stigma of cassava among the Javanese (van Der Eng 1998) and the cultural preference of animal-source foods of Batak people (Simatupang & Simatupang 2016; Siahaan 1993). Both types of food preferences interact with socioeconomic factors, but in different ways. The idea that cassava is food for the poor has caused low consumption of tubers among the affluent Javanese school-aged children. On the other hand, among Batak people, a distinct mechanism applies. Batak people highly value animal-source foods, regardless of their SES. This preference, as was shown in Section 6.1, becomes problematic because of the high price of animal-source foods in Indonesia. The situation caused Batak school-aged children from lower-SES backgrounds to experience a lower dietary diversity. The two cases of ethnic food preferences in this thesis are context specific. However, they highlight that a certain social group could have specific food preferences, which may define their dietary intake and most likely affect their nutritional status.

Third, numerous studies have shown that women's empowerment improves the nutritional status of young children; most research has focused on children under five years of age (Cunningham et al. 2015; Miller & Rodgers 2009; Smith et al. 2003). This thesis adds to the literature by showing that the positive effects of women's empowerment may well extend into adolescence. However, by considering findings of both Chapter 2 and Chapter 3, the effects should be interpreted carefully. It is true that Chapter 2 found mother's education positively correlated with higher HAZ in adolescence. Nevertheless, the following Chapter 3 showed that the same indicator may also increase the chance of being overweight in childhood and adolescence. It could be that the health literacy of educated mothers encouraged them to include nutritious foods in the family diet and motivated them to safeguard the family from pathogenic environments. This trait is perhaps sufficient to secure HAZ—the long-run indicator of nutritional status—, but most likely not enough for maintaining a healthy body weight. As inferred in Chapter 3, context may also affect the role of mother's education on overweight. Supposed the context is the fourth stage of The Global Nutrition Transition, educated mothers' openness to novel diets might unintentionally steer them to introduce high-calorie foods and a sedentary lifestyle to their children. This may lead to overweight and obesity in childhood and adolescence.

Another feature that educated mothers are thought to have is gender-sensitive behaviour related to nutrition (Bose 2011; Khatun et al. 2004). Indian working mothers, for example, spent a certain amount of their earnings to meet the animal-source foods and dairy products needs of their undernourished young girls (Bose 2011). The BRAC initiative is another example (Khatun et al. 2004). Initially, these training and education programmes were meant to scale-up the economic contribution of poor Bangladeshi mothers. The programmes aimed to raise the mothers' awareness to feed young boys and girls equally. This behaviour was quoted as one of the key successes in reducing the gender gap in child nutritional status that the communities had long suffered from.

Would similar gender-sensitive behaviour also characterise Indonesian women? This thesis found a positive association between mother's education and compensation for gender inequality in nutritional status. However, a more complicated mechanism might be at work in Indonesia. Most studies that mention gender-sensitive behaviour of empowered mothers were dealing with a situation where girls are worse-off than boys in nutritional status (Bose 2011; Khatun et al. 2004; Dasgupta 2016; Das Gupta 1987; Aurino 2017; Jayachandran & Pande 2017). The situation was fairly the opposite for Indonesia. Chapter 2, for example, found that on average, Indonesian adolescent boys had a lower BAZ than girls. Additionally, as shown in Chapter 3—using data from IFLS-5 (2014/2015) only—, the youngest cohort of Indonesian boys tends to suffer more from overweight and obesity than girls did. Indeed, Chapter 2 showed that the BAZ of adolescent boys increased along with the level of education of the mother. Hence, educated mothers reduced boys' lack in body mass relative to girls and buffered them from thinness. Nevertheless, would this be sufficient evidence that educated mothers have gender sensitivity that would help their boys improve in nutritional status? This thesis doubts this, particularly because Chapter 3 showed not only that mother's education increased the risk of overweight, but also signalled that the association was gendered, endangering boys more than girls. It might be that a "gender bias in new disguise" was in *modus operandi*. The globalised ideal of how a girl's body shape should be, might persuade Indonesian educated mothers to have concern for their girls' healthy weight—more precisely, socially accepted ideal weight—more than boys. As a result, educated mothers might apply high measures of food supervision for girls, but less so for boys. This gendered food supervision possibly negatively rewarded boys of educated mothers with a greater access to high-calorie foods and thereby exposing them more to overweight and obesity.

6.3. Limitations and suggestions for future research

This thesis has discussed most of its limitations in each empirical chapter. Therefore, this section is aimed to rehearse only the key limitations and to propose a valuable research agenda for future studies. The first key limitation is the lack of age, cohort, and period (APC) analyses, cf. Firebaugh (2006) and Glenn (2005) Although this thesis used multiple waves of IFLS panel data, most analyses were based on pooled data controlled for cohort (birth year) and period (survey year). Limited analyses on age were done in Chapter 3 and 4. This analytical approach produced straightforward, yet useful snapshots of the nutrition condition in Indonesia, allowing this thesis to focus more on the main variables of interest: gender, women's empowerment, and ethnic/religious groups. However, without in-depth analyses of cohort and period effects, this thesis certainly missed the opportunities to create a nutrition-timeline. This nutrition-timeline would be helpful for many to learn from the past, to evaluate the current, and to predict the future of the nutrition situation in Indonesia. This timeline should not only answer an important question of such "Nutrition-wise, where will Indonesia be heading to?", but may also guide policy-makers to develop a long-term nutrition strategy corresponding to forthcoming challenges (e.g., a possibly greater gender bias in dietary intake and an increasing consumption of high-calorie foods).

The second key limitation is the absence of the role of father's education in all empirical chapters. Previous studies have often used parental education as an indicator of SES, e.g. Mandemakers & Kalmijn (2014) and Semba et al. (2008). However, Chapter 3 of this thesis showed that mother's education and household SES are not synonymous. It was shown that while both higher maternal education and higher SES increased the risk of overweight, only mother's education had a compensatory effect on the different risks to boys and girls. This finding should motivate future studies to examine any impact of father's education: questioning what are the roles of fathers? and whether/how father's education differs from mother's education and SES. These future studies could proceed further to capitalise any possible virtue of father's education that neither mother's education nor SES could deliver. A probable hypothesis is that aside from better paid jobs, educated fathers might have more flexible working hours, allowing them to be better involved in caretaking of children. This may include a chance to be a positive dietary model such as previous studies have suggested (Mallan et al. 2014).

The third key limitation is that this thesis focused only on a few social groups in Indonesia. It might have successfully unveiled how maternal Ramadan fasting among pregnant Muslim women and how the high preferences of animal-source foods in the Batak community may negatively shape nutritional status of children and adolescents. However, other food avoidances and food preferences remain unexplored, awaiting future studies. Among these are, for example, the dietary intake and nutritional status of consumers of the Tomohon extreme food market in Minahasa, North Sulawesi. This market has sold meat of wild animals for years, serving the animal-source foods needs of Minahasa people. This practice touches on an increasing concern in South Asia of probable transmission of zoonosis diseases from hunting, butchering, and consuming wild meat (Cantlay et al. 2017). Interestingly, the Tomohon district has the highest nutritional status in Indonesia, with stunting levels of under-five children below 20% (Fanani 2019; Jong 2016). Previous studies have shown that wild animal meat is low in fat and has more nutrients than domestic meat, e.g. Strazdina et al. (2013). Would this be the underlying reason of Tomohon's achievement in nutritional status? Such cultural dietary intake should be within the interest of policymakers in search of better contextual-based approaches to enhance the nutritional status of children and adolescents.

The fourth limitation pertains to how different chapters of this thesis have analysed and interpreted body mass or BAZ. While Chapters 2 and 4 treated BAZ as a continuous scale, Chapter 3 used a different approach, analysing overweight as defined by BAZ ≥ 1 SD. Considering that related to BAZ, malnutrition consists of two classifications: undernourished (thinness) and overnourished (overweight/obese), this difference comes with a consequence. The continuous scale of BAZ used in Chapters 2 and 4 steered both chapters to focus more on undernourishment. It means that the higher BAZ is a preferable outcome. In contrast, Chapter 3 considered that at a certain point BAZ could also be too high to be classified as healthy. It is worth to consider that in future studies, both thinness and overweight should be analysed in a single analytical framework with a specific cut-off value (e.g. thinness BAZ ≤ –2 SD and overweight BAZ ≥ 1 SD), cf. de Onis et al. (2007) and WHO (2006b). Given that in Chapter 2, Indonesian adolescent boys had, overall, a lower BAZ than girls, future studies could examine whether some Indonesian boys indeed struggled with thinness (BAZ ≤ –2 SD). The analyses could then move forward, questioning, for example, who were those thin boys, what is the role of women's empowerment in this matter, and most importantly, what can be done to help children and adolescents who suffer from thinness and overweight regardless of their gender.

6.4. Main conclusions and policy recommendations

This thesis has arrived at the main conclusions and policy recommendations. The main conclusions could be summed-up as follows. First, it was Indonesian boys, rather than girls, that were more likely to experience malnutrition, specifically in body mass or BAZ. While overall, Indonesian adolescent boys had a lower body mass than girls, the latest trend from IFLS-5 (2014/2015) showed that recently more boys were overweight or obese than girls in childhood and adolescence (0–19 years of age). Second, this thesis found that women's empowerment, particularly mother's education, improved HAZ. However, the same women's empowerment indicator inflated gender inequality in BAZ. This was shown in a higher risk of boys of educated mothers for being overweight. This thesis suggested that the higher consumption of high-calorie foods among boys of educated mothers was perhaps the underlying cause of this phenomenon. Third, cultural practices related to food preferences and food avoidances may define variability in dietary intake and nutritional status between and within social groups, including religious and ethnic groups.

Although this thesis was neither meant to evaluate nor to specifically develop nutrition interventions, the findings of this thesis might be useful to enrich the perspective of the current nutrition interventions that policymakers have implemented. It may include, first of all, consideration of the nutritional status of boys besides that of girls. Of course, this does not mean that nutrition interventions targeting girls, especially those regarding adolescents and pregnant women, are not important. Many have agreed that this is the most effective approach to break the vicious cycle of poverty (Elder & Ransom 2003). Furthermore, any improvement in female nutritional status should reward the next generation—regardless of gender—with better well-being, including health, which is the foundation of a strong economy (Remme et al. 2020). However, given an appropriate context, improving the nutritional status of boys could also be a decisive factor in accelerating this process.

In general, Indonesia has egalitarian in gender norms. Unfortunately, the labour market is not among the life domains where this principle applies. The Indonesian labour market has a long history of being male dominated (participation rate of male versus female in February 2020: 84% vs 55%) (Statistics Indonesia 2020). Such a labour force which consists of more males who once were malnourished as boys should dismiss optimal productivity. At the macro-level, this could limit the economic growth. At the micro-level, this may render many households to be nutrition insecure because of the small pay-check these households received from work. Perhaps the ideal approach to overcome the situation is to restructure the gender composition by allowing more of the Indonesian women that this thesis has shown to previously have had better nutritional status as girls, to take part in and to earn from the labour market equally to men. Unfortunately, such transition is unlikely to take place in a near future. This is where improving the nutritional status of boys becomes as important as that of girls. Better nourished men should immediately increase the labour force's productivity, stimulate economic growth, and multiply chances for many households to improve the nutritional status of their sons and daughters. Therefore, nourishing boys and girls equally and encouraging gender equality in the labour force should fast-track the process to break the vicious cycle of poverty.

The second policy recommendation for nutrition intervention and policies is to empower mothers, particularly those who were educated, to be more attentive to the weight of their sons.

Unlike stature, reversing any malnutrition related to either thinness or overweight is viable. Aside from an active lifestyle, a healthy diet should address such malnutrition. Therefore, raising the awareness of mothers to better supervise dietary intake of their boys similarly to that of girls is necessary. Furthermore, educating not only girls but also boys on the benefits of maintaining a healthy diet and an active lifestyle is no less important. This should prepare girls to be more gender sensitive to nutritional status of their children once they enter motherhood. This type of nutrition education should also lessen unwillingness of boys to conform to a strict supervision of dietary intake that their mother imposed.

Third and lastly is to consider the social context of food consumption and dietary intake in assessing nutritional status and designing nutrition interventions for children and adolescents. This thesis has highlighted the negative consequences on HAZ because of the restrictive diet of maternal Ramadan fasting. Some might still argue that this negative effect is minimal. However, considering many studies have confirmed that height is positively associated with economic productivity and individual well-being (Sánchez 2017; Bargain & Zeidan 2016; Sohn 2016), there should be less resistance for policymakers to set a high measure for maternal Ramadan fasting. Furthermore, there is no obligation in Islam for pregnant Muslim women to fast during Ramadan. In relation to this, society should work together to create an enabling environment for pregnant Muslim women not to fast during Ramadan. These pregnant Muslim women should be informed that they have a right to skip Ramadan fasting. Support from the family and consent from Muslim clerics should also be in place. Another important note from this thesis is that gender norms, socioeconomic status, and food culture (food avoidances and food preferences) influenced dietary intake of specific social groups. This should inform policymakers that any nutrition intervention must address dietary differences according to diversities in social context, between and within social groups. Persuading leaders and influencers of targeted social groups to vary their diet could be a starting point to disperse knowledge on dietary diversity to the community at large. Other strategies may include developing a food system that could efficiently produce nutrient-rich foods at a lower price for the society. Nevertheless, it is most important that all these changes should be implemented without risking the diversity in food cultures themselves.

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Summary

Malnutrition is a decisive factor that could detain individual and societal advancements. It may not only reduce individual well-being, but at macro level, could also be a burden for the national health expenditure and the labour productivity. Aside from the economic context, the sociocultural settings a person lives in may influence his/her nutritional status and their significant others. In this case, sociocultural factors operate “invisibly” by influencing people’s beliefs, attitudes, and behaviour toward food and other health inputs. Unlike the extensive efforts that many have put to understand the linkage between economic factors and nutrition, fewer works have been done to reveal the role and mechanisms by which sociocultural factors may affect child nutritional status.

Chapter 1 described the main research objective of this thesis, that is “to examine how sociocultural factors (e.g., gender, religion, and ethnicity) may influence nutritional status in childhood and adolescence (0–19 years of age)”. Indonesia, the world’s fourth largest country in terms of population, is strategically selected for the study site. In response to the main research objective, empirical Chapters 2–5 were then produced. Each chapter studied a specific theme, covering the influence of women’s empowerment (e.g., mother’s education, mother’s bargaining power, and mother’s working status) on adolescent nutritional status (10–19 years of age) in Chapter 2, the role of mother’s education in sibling inequalities (e.g., by gender, birth order, and the number of siblings) in child overweight (0–19 years of age) in Chapter 3, and the effects of maternal Ramadan fasting on the nutritional status of Muslims during childhood and adolescence (0–19 years of age) in Chapter 4, and finally, the influence of ethnicity on dietary diversity—one measure of dietary intake—of school-aged children (7–12 years of age) by gender and household socioeconomic status (SES) in Chapter 5.

Chapter 2 found a positive association between mother’s education and adolescent height-for-age Z-scores (HAZ). Regarding mother’s working status, the chapter showed that adolescents of blue-collar mothers were shorter compared to adolescents of mothers that were housewives. Most likely, the shorter stature was related to the lower food provision and supervision that mother could deliver, considering the long and typically less flexible working hours of blue-collar jobs. There was no influence of mother’s bargaining power on adolescent nutritional status. Gender inequality emerged as boys had on average a lower BMI (body mass index) for-age Z-scores (BAZ) than girls. Mother’s education compensated for boys’ lack in body mass. However, an unhealthy compensating mechanism was likely at work because boys’ consumption of high-calorie foods increased along with more years of mother’s education.

Chapter 3 found that the eldest, the youngest, and children from smaller families were more likely to be overweight. The chapter showed that the risk of being overweight increased with more years of mother’s education, especially for boys and eldest children. Further analyses showed that sons of educated mothers consumed more often high-calorie foods than did their daughters. This gender gap in consumption of high-calorie foods became greater from late childhood onwards (5–19 years of age). Referring to the Global Nutrition Transition, the chapter suggested that the openness to new diets and nutrition innovations of Indonesian educated mothers might take its form in introducing high-calorie foods rather than promoting a healthy diet and an active lifestyle to their children.

Chapter 4 found that prenatal exposure to Ramadan affected the stature of Indonesian children and adolescents. Children and adolescents of religious Muslim mothers who were prenatally exposed to Ramadan were shorter and thinner than their unexposed siblings. This lack in stature developed over time and depended on the timing of the exposure. A cautious analytical design made certain that the cause of the stature deficiency was related more to maternal Ramadan fasting rather than other factors (e.g., alternating diet and sleeping disturbance). Aside from this result, two surprising findings emerged. First, prenatal exposure to Ramadan improved the nutritional status of children and adolescents of less-religious Muslim mothers. Second, negative effects of prenatal exposure to Ramadan on HAZ arose for those who were born to non-Muslim mothers. This occurred in early childhood only (0–4 years of age) but not in later life stages. Both findings were discussed in the light of Indonesia's context, including food price spikes during Ramadan and the timing of the annual bonuses or *Tunjangan Hari Raya* (THR).

Chapter 5 found that dietary patterns of school-aged children differed by ethnic group. Gendered dietary patterns emerged more in children of ethnic groups with a unilineal kinship system, i.e., the patrilineal Batak and the traditionally matrilineal Minangkabau, rather than in the bilateral Javanese. While boys and girls were similar in how frequent they consumed animal-source foods and dairy products, boys of the two unilineal ethnic groups differed in their diet to girls by consuming less often the "low-status" foods (e.g., tubers and vegetables), thus reducing their dietary diversity. The chapter also highlighted how, among Batak children with low-SES, consuming the culturally preferred but expensive animal-source foods was met at the expense of dietary diversity: a behaviour that risked their nutritional status.

Chapter 6 discussed findings of Chapters 2–5 in relation to the main research objective. This led to the following main conclusions. First, Indonesian boys were more likely to experience malnutrition than girls, specifically in BAZ. Second, the mother's education positively influenced HAZ. However, the same indicator of women's empowerment inflated gender inequality in BAZ by exposing boys more to overweight. Third, food culture may be differently related to dietary intake and nutritional status between and within social groups (e.g., religious and ethnic groups).

In terms of policy recommendations, this thesis suggests that alongside the traditional focus on girls, improving the nutritional status of boys should also be on policymakers' agendas. Raising the awareness of educated mothers to better supervise the dietary intake of their sons similarly to that of their daughters is as important. Lastly, the social context of food consumption should also be considered when assessing nutritional status and designing nutrition interventions.

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Wageningen, 10 November 2021

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List of publications

International peer review journals:

Kunto, Y.S. & Bras, H., 2021. Sibling Inequalities and The Role of The Mother's Education in Child Overweight: Evidence from the Indonesian Family Life Survey, *Food and Nutrition Bulletin*, 42(1_suppl), S21-S38. Available at: https://dx.doi.org/10.1177/0379572120976250.

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Kunto, Y.S. & Bras, H., 2018. Women's Empowerment and Gender Inequality in Adolescent Nutritional Status: Evidence from the Indonesian Family Life Survey, *Journal of Biosocial Sciences,* 50(5), 640-665. Available at: https://dx.doi.org/10.1017/s0021932017000566

Proceedings:

Kunto, Y.S. & Bras, H., 2019. Sibling Differences in Overweight and Obesity during Childhood and Adolescence in Indonesia: The Role of Mother's Education, *Proceeding: Annals of Nutrition and Metabolism*, 75, 372-372.

Kunto, Y.S. & Bras, H., 2018. Ethnic Differences in Dietary Diversity of Primary School-aged Children: Evidence from the Indonesian Family Life Survey, *International Conference on Childhood and Adolescence 2018*, Lisbon, PT.

Kunto, Y.S. & Bras, H., 2016. Women's Empowerment and Gender Inequality in Adolescent Nutritional Status: Evidence from The Indonesian Family Life Survey, *The Young Lives Conference 2016*, Oxford, GB.

Yohanes Sondang Kunto
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
WASS Introduction course	WASS	2014	1.0
Research methodology, from topic to proposal	WASS	2014	4.0
Introduction to multilevel analysis	Utrecht University	2015	1.5
Advanced econometrics, AEP 60306	WUR	2015	6.0
Writing research proposal	WASS	2015	6.0
Systematic approaches to reviewing literature	WGS	2016	4.0
'Prenatal exposure to Ramadan fasting and the offspring's physical growth in Indonesia: Does parental education help?'	WASS PhD Day 2016, Wageningen, NL	2016	1.0
'The effect of prenatal exposure on child health in Indonesia: a longitudinal perspective'	European Population Conference (EPC) 2016, Mainz, DE	2016	1.0
'Women's empowerment and gender inequalities in Adolescent Nutritional Status: Evidence from the Indonesian Family Life Survey'	The Young Live Conference 2016, Oxford, UK	2016	1.0
'Does prenatal Ramadan fasting affect childhood and adolescence growth? New evidence from a large Indonesian longitudinal panel study'	Wageningen Indonesian Scientific Exposure (WISE) 2017, Wageningen, NL	2017	1.0
'Women's empowerment and gender inequalities in Adolescent Nutritional Status: Evidence from the Indonesian Family Life Survey'	WASS PhD Day 2017, Wageningen, NL	2017	1.0
'Ethnic differences in dietary diversity among primary school-aged children: Evidence from the Indonesian Family Life Survey'	International Conference on Childhood and Adolescence (ICCA) 2018, Lisbon, PT	2018	1.0
'Socioeconomic status, dietary diversity, and nutritional status of Javanese and Batak children: Evidence from the Indonesian Family Life Survey'	VOICE-IC Conference 2018, Bali, ID	2018	1.0
'Sibling differences in overweight and obesity during childhood and adolescence in Indonesia: The Role of Mother's Education'	Asian Congress of Nutrition (ACN) 2019, Bali, ID	2019	1.0
B) General research related competences			
Scientific writing	Wageningen in'to Languages	2016	1.7
Efficient writing strategy	Wageningen in'to Languages	2016	1.2
Scientific publishing	WGS	2016	0.3
Reviewing a scientific paper	WGS	2017	0.1

C) Career related competences/personal development			
Communication with the media and the general public	WGS	2017	1.0
Social Dutch I	Wageningen in'to Languages	2017	2.4
Social Dutch II	Wageningen in'to Languages	2018	2.4
Total			**39.6**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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