Abdominal Obesity among Older Population in Indonesia:

Socioeconomic and Gender Inequality, Pattern and Impacts on Disability and Death

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Prophet Muhammad ﷺ “Know that victory comes with patience, relief with affliction, and ease with hardship”

(At-Tirmidzi, in An-Nawawi’s 40 Hadits, Hadith 19)
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Abbreviations

AIC  Akaike Information Criterion
BMI  Body Mass Index
CI   Confidence Interval
COPD Chronic Obstructive Pulmonary Disease
CSDH Commission on Social Determinants of Health
CVDs Cardiovascular Diseases
DALY Disability-Adjusted Life-Years
FGDs Focus Group Discussions
GBD Global Burden of Disease
HDSS Health and Demographic Surveillance System
HICs High Income Countries
IFLS Indonesian Family Life Survey
IGT Impaired Glucose Tolerance
INDEPTH International Network of field sites for continuous Demographic Evaluation of Populations and their Health in developing countries
IOTF International Obesity Task Force
LICs Low Income Countries
LMICs Low and Middle-Income Countries
NCDs Non-Communicable Diseases
NHANES National Health and Nutrition Examination Survey
PCA Principal Component Analysis
PHS Purworejo Health Study
RISKESDAS *Riset kesehatan dasar* (primary health research) is a routine health surveillance established by Indonesia ministry of health in 2007 and are collected every three years
SAGE Study on global AGEing and adult health
SES Socioeconomic Status
UNICEF United Nation Children’s Fund
WC Waist Circumference
WHO World Health Organization
WHODAS-II World Health Organization Disability Assessment Schedule version 2
WHR Waist Hip Ratio
Abstract

**Background:** Population ageing has contributed to the rise of chronic non-communicable diseases (NCDs). Concurrently, obesity prevalence is increasing in all age groups and has become a serious public health problem. Obesity is the main risk factors of the major chronic NCDs such as type 2 diabetes and has been linked to disability and mortality. Studies of socioeconomic inequalities in obesity among older people in Indonesia are scarce. Understanding socioeconomic inequalities are essential to develop appropriate health programme to improve the population health. This thesis describes the pattern of socioeconomic and gender inequality in abdominal obesity and analyses its impact on disability and all-cause mortality among older people in Indonesia.

**Methods:** This thesis is based on four studies conducted in Purworejo Health and Demographic Surveillance System (HDSS) site in Purworejo district, Central Java, Indonesia. This thesis uses both quantitative and qualitative methods. The qualitative study (sub-study 1) was based on 12 Focus Group Discussions (FGDs) with 68 participants from different age groups, sex, and living area. Content analysis was used to describe the community perceptions on diabetes and its risk factors. The quantitative studies (sub-study 2 to 4) utilized longitudinal panel data from the 1st \((n = 11,753\) individuals) and 2nd wave \((n = 14,235\) individuals) of the WHO-INDEPTH Study on global AGEing and adult health (SAGE) conducted among all individuals aged 50 years and older in 2007 and 2010. Sub-study 2 used concentration index and decomposition analysis to analyse the pattern of socioeconomic and gender inequality in abdominal obesity. Sub-study 3 used linear regression to examine the association between abdominal obesity and disability. Sub-study 4 used Cox regression analysis with restricted cubic splines to examine the impact of abdominal obesity on all-cause mortality.

**Results:** The FGDs reveals that the community holds unrealistic optimism in perceiving diabetes its risk factors. The community stated that chronic NCD such as diabetes is caused by modern lifestyles and mostly attacks those who are considered as the wealthy (sub-study 1). Socioeconomic inequality in abdominal obesity exists in Purworejo HDSS. Abdominal obesity was more prevalent among the affluent men and women, with a lesser inequality gaps between rich and poor among women. The main contributing factors to inequalities in abdominal obesity were occupation, wealth index, and education (sub-study 2). In three-year period, the mean waist circumference decreased significantly among the poor. An increase in waist circumference was significantly associated with disability, and the poor people were
more disabled compared to the rich (sub-study 3). A U-shaped association was observed between waist circumference and all-cause mortality, particularly among women. This indicated an increased risk of mortality in the lower and upper end of the waist circumference distribution. The poor with low waist circumference had a higher risk of mortality than the rich (sub-study 4).

**Conclusion:** Abdominal obesity was disproportionately more prevalent among older Indonesian women. Though the wealthy people have higher burden of abdominal obesity, the poor people experiences more disability and higher risk of death. Misperception on chronic NCDs and its risk factors exist among the Indonesian population. Abdominal obesity prevention strategies are needed to prevent chronic NCDs, disabilities, and mortality among Indonesian older population. The prevention strategies should be culturally sensitive and address all socioeconomic levels. Special attention should be given to disadvantaged women as the most vulnerable group.

**Keywords:** Abdominal obesity, concentration index, disability, focus-group discussion, gender inequality, Indonesia, mortality, older people, socioeconomic inequality.
The thesis is based on the following papers, referred to as studies 1-4:


The original papers are published in Open-Access journals, and the authors retain the right of the published papers.
Prologue

It all started in 2002, when I was in the third year of my undergraduate study in the nursing programme at Gadjah Mada University, Yogyakarta, Indonesia. At that time, I was involved as a surveyor in a research collaboration between Japanese and Indonesian researchers with a research project whose topic was diabetes mellitus, a disease that cannot be cured.

As I became more involved in the research, I observed that diabetic patients faced a common issue. Every time that I interacted with them they told me that it was difficult to comply with doctor’s ‘do’s and don’ts’ with regard to their diet and exercise habits. They were definitely experiencing difficulties in managing their diabetes. It was then that I found myself interested in this area of research.

My interest in diabetes research grew into a thesis proposal that was focused on self-efficacy among diabetes patients in Yogyakarta, Indonesia, and Kobe, Japan. The Japanese researcher helped me to connect and collaborate with a Japanese student who had a similar interest.

In 2004, Dr. Nawi Ng introduced me to the Umeå International School of Public Health (UISPH) and suggested me to continue my education in the Master of Public Health programme. I registered as master student in UISPH in 2006. My perspective on public health and my epidemiological studies has broadened and as a result I became very interested in doing population-based research. At the end of 2009, I presented my research proposal, with diabetes type 2 as my main topic of interest. From there, the unimaginable journey began.

The Purworejo Health Study (PHS) began in 2010. The survey consists of two quantitative studies, namely a Non-Communicable Diseases (NCDs) study, and a WHO-INDEPTH Study on global AGEing and adult health (SAGE); and one qualitative study on general community perceptions on diabetes mellitus and its risk factors. By the end of 2010, we had finished the quantitative data collection. The focus group discussions (FGDs) for the qualitative study were then conducted in 2011-2012.

From my first attempt at research in undergraduate school, I have learnt that there are lots of obstacles to research. In common with these prior experiences, the obstacles in this project arose mainly during data collection. No matter how precise we are in our plans, there is always something that is unpredictable, and is out of our control. My thesis project that had initially used the data from the NCDs study and the qualitative study needed to be changed (yes, it was a nightmare).

If I write in detail about my ‘voyage’, this prologue will become a novel. I changed the plan and the analysis countless times, with the latest one being in your hand right now. I utilised the data from the qualitative study and the WHO-INDEPTH SAGE.
The qualitative study showed me ‘the bigger picture’ of how the general population appear to view a chronic disease such as diabetes and its risk factors. From there I ‘zoomed-in’ on one main risk factor of chronic diseases that had been mentioned in the FGDs: obesity. Obesity is a rising problem in Indonesia. In the FGDs, the respondents mentioned that they notice obesity only among those who are rich. This contrasts with findings in high-income countries, where research shows that those who are poor are at a higher risk of consuming an unhealthy diet that results in obesity and poor health. Therefore, I chose to analyse socioeconomic and gender inequalities on obesity and examine its impact on disability and death.
Introduction

This chapter introduces several key concepts that are used in the thesis, including the growth of the older population; the concept of ageing, with a focus on health; the concept of nutrition transition, obesity and its health consequences; and socioeconomic and gender inequalities as social determinants of health. The last part of this chapter will contextualise the concepts within the Indonesian setting.

Growth of the older population

Worldwide, the number and proportion of older people has increased rapidly. In 2015, 8.5% out of 7.3 billion people worldwide were aged 65 and older, which is equivalent to 617 million people out of the total population. In 2030, the corresponding numbers will be 12% and 1 million and, in 2050, 17% and 1.6 billion (1). The increasing proportion of older people together with the associated health and social consequences have led to an increased interest in studies among older people.

Demographic transition, defined as the transition from high fertility and mortality rates to low fertility and mortality rates as a country become industrialized. Demographic transition is the key factor in population ageing. In high-income countries (HICs), the size of the older population continues to rise, mainly due to low fertility and declining mortality among those of older age. Meanwhile, in low- and middle-income countries (LMICs), the increasing size of the older population is a result of declining fertility and mortality rates among those in younger age groups due to decreasing mortality rates from communicable diseases (2).

Europe has been the most-aged region and will remain so through to 2050 (1). In 2015, more than 17% of Europeans were aged 65 and older and this is projected to increase to 27% in 2050 (1). Nevertheless, demographic transition and population ageing in Asia are progressing rapidly. The number of older people in Asia is expected to rise from 8% of the population in 2015 to almost 19% in 2050. Given its enormous population size, 19% in Asia equates to 975 million people, compared to the 27% in Europe, which translates into just 199 million (1). The increasing older population will eventually increase the likelihood of health problems, especially chronic morbidities, disabilities, and mortality (2).

Ageing and the health consequences

Health is the essential factor that determines how older people contribute to their immediate communities. If people are experiencing their older age in good health, they will contribute positively to their society. However, by its nature, ageing results in a deteriorating strength and physical health that may lead to morbidities and
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disabilities. If morbidities and disabilities are dominant factors in the older ages, the implications of ageing may be detrimental to society (3).

Most of the health problems among older people are associated with chronic non-communicable diseases (NCDs) such as cardiovascular diseases (CVDs), hypertension, diabetes mellitus, osteoarthritis, dementia, cataract, urinary incontinence and cancers (2, 4-6). In South-Eastern Asia, CVDs and stroke account for 20-40% of the old age mortality rate (7, 8). However, advances in medical technology have improved the survival rate from chronic NCDs deaths. Consequently, this increasing longevity may increase chronic NCD-related disability. Furthermore, as disabilities increase with increasing age, governments will be challenged to provide long-term care and social services for their ageing populations, which places further pressures on national health expenditures (9).

Globally, levels of overweight and obesity across all age groups are greater today than they were a decade ago (10). The National Health and Nutrition Examination Survey (NHANES) which was based on the US population shows an increase in obesity prevalence (Body mass index (BMI) ≥ 30 kg/m²) from NHANES 1988-1994 to NHANES 1999-2000 in all age groups. However, the increase is higher in the 60-69 age group than in other groups, where obesity increases by 13.3% in men and 12.7% in women (11).

Nutrition transition and obesity

The concept of nutrition transition, was first proposed by Barry Popkin, has been focused on large shifts in diet and physical activity patterns. Nutrition transition theoretical constructs match those of epidemiological, demographic and economic transitions. Nutrition transition is manifested in five stages: 1) hunter-gatherers or collecting food, 2) famine, 3) receding famine, 4) degenerative disease, and 5) behavioural change (12). The hunter-gatherer or collecting food stage refers to a stage where individuals are engaging in highly active lifestyles, with diets rich in fibre and high in protein from lean wild animals. The famine, or early agriculture, stage refers to a period of starvation, which decreases individuals’ body fat and slows down their growth. The receding famine stage refers to the rise of agriculture: famine recedes, nutrition improves, and income rises. The penultimate stage is overeating and obesity-related diseases, such as NCDs, as a result of rising incomes where individuals have access to an abundance of unhealthy food and engage in sedentary lifestyles. The last stage is behavioural change: a response to increasing rates of obesity and its consequences where individuals change their behaviour to prevent further health problems (12-15).
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Nutrition transition occurs in most regions of the world, with changes occurring most rapidly in LMICs (15). There can be shifts away from diets higher in fibre towards those that are higher in fat and meat, and more self-gratifying diets with their higher sugar content; as well as a shift away from physical activity and labour-intensive activities (12-15). Dietary and physical activity changes are desired by individuals in many ways as they point to higher socioeconomic status. The rapid shift in the way people eat, drink, and move, and the subsequent energy imbalance will lead to obesity and carry with them many unwanted health effects (14, 15).

Obesity

Obesity is a complex problem, as illustrated in 2007 by a conceptual model, published by the Foresight Programme of the Government Science Office in the United Kingdom (16). The model makes links between the obesity problems from more than one hundred proximal and distal factors clustered into individual and societal levels, all of which are interrelated through more than three hundred connections and more than one hundred feedback loops. Obesity is caused by multiple factors that involve many disciplines (16).

One cause of obesity, the biological cause, was revealed through an evolutionary perspective: namely the ‘thrifty genes’ and ‘thrifty phenotypes’ hypotheses (17, 18). These hypotheses have suggested that human survival increases during periods of famine. The ‘thrifty genes’ hypothesis explains that during periods of starvation, genes adapt themselves so as to preserve glucose and store the energy efficiently as fat. The ‘thrifty phenotypes’ hypothesis explains that undernutrition during foetal and post-natal stages changes the metabolic pathways where the foetus adapts to the careful use of nutrients. If these adaptations are preserved into later life, where nutrition settings are adequate, they will lead to obesity (17, 18).

In general, obesity occurs due to an imbalance in energy intake and expenditure (19). In most countries across the world, the economic transition that is marked by industrialisation and urbanisation has increased population income and improved economic levels (12, 20). The economic growth has ensured food availability and changed the occupational and leisure time patterns. In these societies with economic transition, the standard of living continues to rise, food is plentiful, and exercise is optional (15). This plentiful food is often loaded with energy (added sugar, saturated fat), and taken in bigger portion sizes. At the same time, sedentary activity cannot be avoided in many workplaces and leisure activities (15). Excessive calorific intake and physical inactivity are the main factors related to obesity. Thus, obesity might be attributable to unnecessary energy intake or decreased physical activity, or a combination of the two.
Economic transition, especially urbanisation and globalisation, are among the reasons for the increasing prevalence of obesity (15). It results in the increasing availability of food supplies, expansion of global food industries (with aggressive advertising), changes in dietary patterns (where unhealthy foods become more available and affordable), motorised private transportation and more sedentary activities during leisure time (i.e., watching television/increasing sitting time) (21-23). Government policy on international trade and liberalisation is one of the crucial factors that drive the economic transitions in these countries (24).

The World Health Organization (WHO) reported that the global prevalence of obesity doubled between 1980 and 2014 (25). The Global Burden of Disease (GBD) study in 2013 showed that the top ten countries with the most obese individuals were the USA, China, India, Russia, Brazil, Mexico, Egypt, Germany, Pakistan, and Indonesia (listed in order of the number of obese individuals). More than 50% of 671 million obese individuals in the world live in these ten countries (26). Its increasing prevalence in most countries makes obesity not an exclusive issue for HICs, but emergent for LMICs too as it will strain their national health care systems (9, 27, 28).

The GBD study also reported that, in 2010, overweight and obesity were estimated to have caused 3.4 million deaths, 3.9% of years of life lost, and 3.8% of disability-adjusted life-years (DALY) globally (26). These estimates had increased in the 2015 GBD study, where overweight and obesity contributed to 4.0 million deaths, and 4.9% DALY globally (10). One of the major causes of chronic NCDs is obesity. Obesity contributes to physical impairments and determines early onset of chronic NCDs and their severity (19). This makes overweight and obesity growing threats to human health (13-15).

Cultural factors and populations’ perceptions of obesity also play an essential role in the burden of obesity. In most HICs, obesity is negatively associated with life satisfaction. In HICs, women particularly are dissatisfied with their body image and prefer a thinner silhouette (29). In contrast, in many LMICs, such as Africa, Samoa, and Indonesia, obesity is considered as a sign of prosperity and wellbeing. They are believes that larger body size reflects higher social strata (30-32). A recent study in Indonesia showed a positive association between obesity and happiness (32).

*Health consequences of obesity*

Several studies have explored the biological basis of obesity consequences through the mechanistic perspective, which suggests that a number of fat-derived molecules are linked to inflammation and underlie the link between obesity and metabolic abnormalities (17, 18). Obesity causes metabolic changes, including raised blood pressure, adverse cholesterol levels, insulin resistance and impaired glucose
intolerance (IGT), also known as metabolic syndrome (17, 18). Metabolic syndrome will further develop into chronic NCDs such as CVDs, diabetes, and certain cancers (17, 18).

Obesity is a key risk factor for developing chronic NCDs (25). Obesity contributes to physical impairments and determines early onset of chronic NCDs and their severity (19). Data from the GBD study showed that, worldwide, 41% of BMI-related deaths and 34% of BMI-related DALY were due to CVD among obese individuals. The second leading cause of BMI-related deaths was diabetes, where 9.5% deaths occurred at BMI $\geq$ 30 kg/m$^2$ and 4.5% at BMI < 30 kg/m$^2$ (10).

The epidemic of chronic NCDs occurs alongside ageing populations (2, 33). Chronic NCDs such as diabetes mellitus, hypertension, and CVDs increase with age and have significant effects on disability (5, 6, 33). In HICs, the prevalence of disability in 2004 was as high as 43% among older people aged $\geq$ 75 years old compared with 19% among those aged 55–64 years old. The corresponding numbers in the low-income countries (LICs) are higher at 60% and 29%, respectively (33).

According to the WHO, in 2012 NCDs were responsible for 38 out of 56 million deaths worldwide, with CVDs, diabetes, cancer, and respiratory diseases as the leading causes (25). Approximately 42% of these deaths occurred before the age of 70, and the majority of the premature deaths occurred in LMICs. In South-East Asia, between 2000 and 2012, the number of NCDs deaths increased in South-East Asia from 6.7 to 8.5 million (25).

On the other hand, being underweight or having weight loss among older adults is known to be associated with both morbidity and mortality (34-37). The potential harmful effects of obesity to, and the benefits of weight loss in, the older adults has been much debated (38). Monitoring and maintaining a healthy range of weight has been recommended in many studies (37, 39-41).

Diabesity epidemic

Factors related to nutrition transition, i.e. diet shifts and reduced physical activity levels which lead to obesity, are a major determinant of diabetes in adulthood or type 2 diabetes. The closely-tied increases in obesity and diabetes have been referred to as the ‘diabesity epidemic’. Adipose tissue is an important endocrine organ that produces a number of adipocyte hormones and cytokines, that have essential roles in the regulation of insulin sensitivity, glucose metabolism, and other physiological functions. Therefore, it is not surprising that overweight/obese people are at higher risk of type 2 diabetes. In short, obesity is paving the way for IGT, which further progresses to type 2 diabetes (18).
Research has clearly shown that increases in the prevalence of obesity are closely linked to an increasing prevalence of type 2 diabetes (42). The NHANES which was conducted among 21,000 adults in the US, found that type 2 diabetes risk rises to 43% for obese individuals (43). Another prospective study among healthy adults in Japan aged 30-59 years found that the risk of type 2 diabetes rises by 25% with an increase in BMI of 1 kg/m², equal to a body weight gain of 2.4 to 2.9 kg (44). Freemantle et al. in their systematic review of show a strong association between abdominal obesity and the incidence of type 2 diabetes (45). They conclude that reducing waist circumference may reduce the risk of developing type 2 diabetes (45).

Research has also shown that being overweight or obese in early and middle age predicts an increased risk of type 2 diabetes in older age (46-49). In Scotland, Hart et al. followed men and women for almost 30 years and found that around 60% of type 2 diabetes incidence was attributed to being overweight (46). Another prospective study among Swedish women aged 39-65 years showed an increased risk of developing type 2 diabetes over 18 years with an increasing BMI (47). A report of the British Regional Heart Study that followed men aged 40-59 years for over 20 years also found a strong association between overweight and obesity and the risk of developing type 2 diabetes (49).

*Obesity measurements*

Obesity is defined as excessive body fat accumulations in the adipose tissue. There are several methods to estimate the body fat accumulations. Anthropometry assessment, such as BMI, waist circumference, and waist hip ratio (WHR), are often used in population-based studies and clinical practice due to their cost-effectiveness (19).

Measurements of what constitutes excessive body fat accumulations and its elevated health risk in older adults is controversial. The WHO guidelines recommend the use of BMI. BMI is calculated by dividing a person’s weight in kilograms by their height in metres squared (kg/m²). BMI classifications are: underweight < 18.5 kg/m²; normal weight 18.5-25 kg/m²; overweight 25-30 kg/m²; obese 30-40 kg/m²; and severely obese ≥ 40 kg/m². However, age-related reduction in height will falsely estimate an increasing BMI despite minimal changes in weight (50). Many studies have also addressed BMI’s limitations as it cannot distinguish between fat mass and non-fat (lean) mass (38, 51, 52).

Snijder et al. summarised the capability of different body fat measurements (Table 1) (53). They concluded that, with regard to the purpose of the study, anthropometry measurements were the most simple, quick and cheap methods of obesity measurement. However, waist circumference may be the best alternative for
capturing information on visceral fat and is less affected by variation in lean mass, for example within the older population (53).

Changes in body fat distributions by age have been documented in several studies (38, 51, 52). Vlassopoulos et al. reported that after the age of 70, the BMI tended to decrease, while the waist circumference continued to increase, indicating the redistribution of body fat towards the abdominal region (54). This leads to a discussion on the most effective ways of measuring obesity among older people. Using BMI (weight-based measurement) for assessing obesity among older people can be misleading due to loss of mass. Several studies have recommended waist circumference measurement instead (5, 54).

**Table 1.** Capability of different body fat measurements in estimating total body fat and fat distribution and its applicability to population studies.

<table>
<thead>
<tr>
<th>Method</th>
<th>Capability measuring</th>
<th>Applicability in population studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computed tomography</td>
<td>Moderate</td>
<td>Very high</td>
</tr>
<tr>
<td>Magnetic resonance imaging</td>
<td>High</td>
<td>Very high</td>
</tr>
<tr>
<td>Dual energy X-ray absorptiometry</td>
<td>Very high</td>
<td>High</td>
</tr>
<tr>
<td>Densitometry</td>
<td>Very high</td>
<td>Very low</td>
</tr>
<tr>
<td>Dilution techniques</td>
<td>High</td>
<td>Very low</td>
</tr>
<tr>
<td>Bioelectrical impedance analysis</td>
<td>Moderate</td>
<td>Very low</td>
</tr>
<tr>
<td>Anthropometry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass index (BMI)</td>
<td>Moderate</td>
<td>Very low</td>
</tr>
<tr>
<td>Waist circumference (WC)</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Hip circumference</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Waist hip ratio (WHR)</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Sagittal abdominal diameter</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Skinfolds</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

*Source: Snijder et.al, 2006 (53)*

Studies of populations throughout the world have suggested using ethnic-specific cut-off points in defining obesity (55, 56). According to the WHO International Obesity Task Force (IOTF), Asian-Pacific cut-off values for BMI are: underweight < 18.5 kg/m²; normal weight 18.5-22.9 kg/m²; overweight 23-24.9 kg/m²; and obese ≥ 25 kg/m² (57). Gurrici et al. in their study about the relationship between percent body fat and BMI among Dutch Caucasians and Indonesian calculated the cut-off value for obesity in Indonesian adult population at ≥ 27 kg/m² (58).

Studies among Asians also show an increased metabolic risk at lower waist circumference than for Europeans, due to their greater amount of visceral adipose
tissue and the higher percentage of body fat (59-62). These studies also indicated the importance of implementing of a lower waist circumference cut-off point for Asians (63, 64). This thesis will use waist circumference cut-off points for Asian populations as recommended by the WHO expert consultation report on waist circumference and waist-hip ratio, in which abdominal obesity is defined as a waist circumference of ≥ 90 cm for men and ≥ 80 cm for women (56, 65).

**Socioeconomic and gender inequality as determinants of health**

*Socioeconomic inequality*

Socioeconomic inequality became an important issue in public health policy after the publication of The Black Report in England and Wales in the 1980s. The report pointed out a strong association between socioeconomic status (SES), ill health and death (66). Poor SES is associated with malnutrition, low levels of education, high-risk types of work, overly-crowded living conditions, and mental health disorders (66). Socioeconomic status determines how people are treated by others, what health services are affordable to them, and how well the treatments are received by them (66).

Three decades after the Black report, health inequalities remained one of the leading public health challenges in the United Kingdom and globally (67). The ‘Fair society and healthy lives’ report by Sir Richard Marmot revealed that people living in the most impoverished areas died seven years earlier compared to those living in the wealthiest areas (67). Recent studies showed that risk factors, such as smoking, hypertension, and obesity (68), chronic NCDs (69) and chronic NCD deaths (70) were more prevalent among individuals in the lower socioeconomic groups. Tackling health inequalities is a priority for many healthcare systems globally (71).

Unlike in HICs, most of older people in LMICs are not in paid workforce and without social welfare or pension insurance scheme. Thus, most of older people, particularly in LIMICs, are at higher risk of poverty compared with their younger counterparts. Poverty in turn jeopardises the health and wellbeing of older people. They are also more likely to be trapped in financial hardship due to their deteriorating health and therefore unable to afford the required health care (72). Among the population with low SES, a nutritious diet is difficult to reach due to the likelihood of food insecurity, the limited access to and affordability of healthy food. In addition, a limited suboptimal access to health care making a good health being out of reach for the population with low SES (73).

The association between SES and obesity has been studied extensively in HICs. In HICs, a higher prevalence of overweight and obesity was observed among those with low SES (70, 74, 75). A recent prospective cohort study of people aged 50 years and
older in England showed that obesity was more prevalent among the poor (70). Contrarily, in LMICs, people with high SES and high education were more often overweight or obese than people with low SES (15, 76, 77).

*Gender inequality*

Gender roles and norms shape everyday experiences throughout the course of life (78). Gender inequality intersects with socioeconomic inequality. It is entwined with education, employment status, income, health, access to health care, and physical and sociocultural environments (78). For example, women have a lower chance of accessing education than men because their parents think that the investment return from educating girls may be lower than it is for boys, as daughters will be part of a separate household unit when they grow up (78).

Similarly, the risk factor exposures and health status can be very different between men and women, depending on their society, socioeconomic and cultural situation (78, 79). Gender roles and norms determine access to health services and health information. Thus, these gender roles and norms contribute to unequal health outcomes (80). For example, pain and difficulty in childbirth is often viewed as a natural process for women. In the case of prolonged labour in certain societies, the husband decides when to take her to the hospital or seek and provide more advanced medical care (80). These situations often result in inadequate care, complications, and even maternal mortality. In some cultures, women may be precluded from physical activities, while men have freedom to choose.

Since gender roles influence health across the course of life (79, 81), men and women will experience ageing processes differently. Due to their caregiving role within the family, women rarely have a full-time job outside the home (3). They may also have had interrupted employment histories due to family responsibilities that resulted in lower wages and lower pensions (3). Thus, women are among the most deprived groups in most societies (82).

The higher proportions of poor and unhealthy older women are influenced by the gender roles and women’s higher life expectancy (3, 83, 84). Women have a higher life expectancy compared to men (85, 86). Therefore, the majority of older adults are women. Research has shown that women living alone or as heads of families were the least healthy (83, 84). The likelihood of being widowed and unmarried was also higher among women compared to men (3, 83, 84, 87).
INTRODUCTION

Indonesia: a country in transition

The country's geography and demography

Indonesia ranks fourth in the most populous countries in the world and is home to 262 million people with more than 300 ethnicities and 700 local languages (88). Indonesia, a Southeast Asian nation, is a huge archipelago of islands scattered along the equator between the Indian and the Pacific Oceans (Figure 1). As it lies along the equator, Indonesia’s tropical climate remains fairly constant with a temperature average of 26-28°C in the inland and coastal areas. Indonesia has two seasons – a rainy season that falls between November and March and a dry season falling between April and October.

During the past three decades, Indonesia has experienced a rapid demographic transition that has changed the age structure of the population (Figure 2). In 1975, the Indonesian population pyramid was characterised by its wide base. In the year 2000, the pyramid base was narrowed, indicating a decreasing proportion of children aged 0-4 years old (42% in 1975 and 28% in 2000), mainly due to declining fertility rates (80). Between the years 1960 to 2015, Indonesia’s fertility rate has dropped from 5.7 to 2.4 births per woman (89).

![Figure 1. Map of Indonesia](http://legacy.lib.utexas.edu/maps/middle_east_and_asia/indonesia_physio-2002.pdf)
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Figure 2. Population pyramids of Indonesia (1975, 2000, 2025, 2050).
*Source:* Health in Asia and the Pacific (80).

Figure 3. Demographic trends in Indonesia, population projection during 2010 – 2050.
*Source:* Priebe and Howell, 2014 (Data are from World Bank 2012 population projection) (90).
The number of persons in the age groups 35-59 and 60+ is steadily increasing, while the number within the younger age groups, less than 35 years old, are decreasing (Figure 3). The total life expectancy increased from 49 years in 1960 to 69 years in 2015 (89), as the country has made significant progress in reducing the prevalence of infectious diseases as well as in advancing medical technology that has reduced mortality-related chronic NCDs (91).

_Ageing in Indonesia_

The terms ‘elderly’ and ‘older persons’ are often used to mean those aged 65 years and older (3). In this thesis, ‘older persons’ refer to those aged 50 years and over.

Ageing is a complex process involving biological, psychological and social factors that are unique to each individual and which result in individual differences in functional age (i.e. ability to perform activities of daily living). Hooyman and Kiyak define ageing as “changes that take place in the organism throughout the life span – good, bad or neutral” (3). However, each of us may differ in the way we react to old age, as the social stratification of age varies across cultures and the specific effects of ageing are influenced by multiple factors such as socioeconomic status and living environment, i.e. urban vs. rural areas (3).

In Indonesia, particularly among the Javanese people, most older people (aged 55 years old) still live with their child or at least have one child living in close proximity (92). Unlike Sweden that has a well-developed welfare system that provides comprehensive geriatric care (93), in Indonesia children have an obligation to take care of their parents (94). Intergenerational relationships are considered very important to elderly care in Indonesia (94). The time when the parents are no longer economically productive or fall ill is the time when they started to live with their children, preferably younger daughters (92). The situation of economically-productive older people varies depending on whether they live in urban or rural areas. Those who live in the city usually retire at the pension age of 55 years (e.g. government workers or private company workers), while those who live in the villages continue to work beyond pensionable age (e.g. farmers or fishermen) (92).

_Nutrition transition and obesity epidemic in Indonesia_

Indonesia has improved its economic status, marked by industrialisation and acceleration of urbanisation. This rapid economic growth paves the way for nutrition transition paralleled by epidemiological transition. Epidemiological transition is characterised by shifting patterns from a high prevalence of infectious diseases that are often associated with nutrition deficiency, towards a high prevalence of chronic
NCDs that are often associated with ‘modern’ food (i.e. high in saturated fats, salt, sugar and low fruit and vegetable intake) (15, 76, 95, 96).

Data from the National Basic Health Survey (RISKESDAS) in 2013 showed that the prevalence of low fruit and vegetable intake among people aged over 50 was 96%. Furthermore, RISKESDAS also assessed other unhealthy food consumption behaviour such as salt and sugar intake and fatty food consumption. More than 45% of people in the same age range consumed fatty food 1-6 times per week, and more than 54% of them consumed sweet food on a daily basis (≥ 1 times per day) (97).

The nutrition transitions are also accompanied by sedentary physical activity which has consequently contributed to a significant increase in the prevalence of overweight and obesity (15, 76, 95, 96). The prevalence of obesity has increased constantly in Indonesia in the last decade (30, 77, 98). A study using the Indonesian Family Life Survey (IFLS) data showed that between 1993 and 2007 the obesity prevalence (BMI > 27 kg/m²) increased from 9.7% to 20% among women and from 4.0% to 8.9% among men (30). The study also showed that mean BMI has increased in both urban and rural areas, with a slightly higher increase in rural areas (from 20.5 to 21.4 among men and from 21.1 to 22.9 among women) than in urban areas (from 21.8 to 22.5 among men and from 22.8 to 23.9 among women) (30). An increase in the average BMI might indicate either an improvement or deterioration of nutritional wellbeing within the population. In both urban and rural areas, obesity was more pronounced among Indonesian women (30, 77, 99).

The RISKESDAS shows the increasing prevalence of abdominal obesity in all age groups during 2007 and 2013 (Figure 4). On average, the prevalence increased about 1.5 times in women (from 29% to 42%), those who lived in urban areas (from 24% to 31%) and in the wealthier groups (from 20% to 31% and from 23% to 36%, in the 4th and 5th quintile respectively) (97).

In Indonesia, the prevalence of diabetes mellitus increases with age (Figure 5). The highest prevalence was observed in the age group 65+ (14.3%). Diabetes was found to be higher among women (7.7%), slightly higher in rural rather than urban areas (8.8% vs. 6.4%), and its prevalence increased from poorer to wealthier quintile.

In 2017, the WHO NCDs progress monitor reported that the percentage of NCDs deaths in Indonesia reached 73% (100). Chronic NCDs such as CVD, diabetes mellitus, cancer, and chronic respiratory diseases, are the leading causes of death in Indonesia (100). The WHO NCDs progress monitor also reported that although public education and awareness campaigns about the importance of physical activity were fully achieved, unhealthy diet reduction policies, such as salt/sodium and saturated fatty acids and trans-fats policies, were not achieved (100). Indonesia is still facing a massive burden of NCDs deaths (100).
Figure 4. Prevalence of abdominal obesity (men ≥ 90 cm and women ≥ 80 cm) among men and women aged 15 years and older in Indonesia, in year 2007 and 2013.


Figure 5. Prevalence of diabetes mellitus among men and women aged 15 years and older in Indonesia in 2013.

Source: adapted from ‘State of Health Inequality Indonesia, 2017’ (data are from RISKESDAS 2013) (88).
INTRODUCTION

Figure 6 shows the diabetes mellitus prevalence among men and women aged 15 years and older in Indonesia in 2007, stratified by BMI, abdominal obesity, fruit and vegetable consumption and physical activity level. The prevalence of diabetes mellitus was higher among the obese (BMI > 27 kg/m²), abdominally obese (men ≥ 90 cm, women ≥ 80 cm), those who had fewer than 5 portions of fruit and vegetables per day, and those who were less active.

A recent study on obesity and socioeconomic inequality in Indonesian men and women aged 20+ showed that the proportion of obesity (BMI ≥ 25 kg/m²) increased rapidly between 1993 and 2014 (102). Even though the prevalence rates were higher among the affluent groups throughout the study period, obesity has rapidly becoming more prevalent among less wealthy groups. The growth of obesity among disadvantaged groups was higher than that of the advantaged groups throughout the entire study period (102).

National strategy in tackling chronic diseases in Indonesia

The Government of Indonesia started to recognise and to act upon the growing problem of chronic NCDs in the late 1990s (88). The Indonesian Ministry of Health has introduced several national action plans to prevent and control chronic NCDs and their risk factors (88, 103). The action plans introduced in 2015-2016, namely the ‘Gerakan Nusantara Tekan Angka Obesitas (GENTAS)’ [the Nusantara or national movement to reduce the obesity rates] programme aimed to lower obesity rates, the ‘Gerakan Masyarakat Hidup Sehat (GERMAS)’ [healthy community movement] and
‘Program Indonesia Sehat dengan Pendekatan Keluarga (PIS-DPK)’ [healthy Indonesia programme with family approach], aimed to control and prevent NCDs (104, 105).

GENTAS and GERMAS are national community movement programmes, which include promotions on healthy lifestyle (increase physical activity) and healthy eating (reducing sugar and salt intake and encouraging more consumption of fruits and vegetables) as well as strengthening the prevention and early detection of NCDs (104, 105). The PIS-DPK is a government action aimed at strengthening the primary care unit or community health centre to prioritise preventing and obliterating NCDs at a family/individual level by utilising ‘Posbindu’, a community-integrated programme, that mainly works across schools and residential homes (104, 105).

The government, however, may need to evaluate these programmes, ascertaining whether they reach all community levels in each province and whether they are in line with the local traditions/cultures. The government also needs to develop relevant strategies in different areas; i.e. promoting the use of public green space to increase physical activity in more developed areas, while educating the less developed areas on healthy food choices and maintaining physical activity levels.

The Indonesian government has also recognised the existence of health inequalities throughout its country (88). Inequalities in health service coverage, access to health care, health-related behaviours, disease-management and outcomes were observed between and within provinces (88). Recently, the government has committed to addressing national health inequalities by implementing a 5-step cycle of health inequality monitoring: this will include determining the scope of monitoring, obtaining necessary data, analysing data, reporting results and implementing changes (88).

Research in context

Between 1990 and 2016, health across many indicators has substantially improved in Indonesia. However, due to the country’s size, diversity and socioeconomic disparities within the provinces, the health improvements have not been equally achieved in all subgroups (91). A growing number of chronic NCDs and the rising number of disabilities and deaths caused by chronic NCDs is offsetting health improvements and placing a burden on the nation’s health system, in tandem with the remaining problem of communicable diseases (91).

Data reflecting the regional disparities in morbidity, mortality, and disability are needed to improve the health in a specific region or population that is lagging behind or receiving less attention. More studies are needed to better understand the diverse characteristics of health in a specific region or population.
The thesis explores local community perceptions of type 2 diabetes and its risk factors as an example of chronic NCD. This thesis then addresses abdominal obesity as one of the main risk factors for chronic NCDs. It analyses the pattern of socioeconomic and gender inequality in abdominal obesity and examines the consequences of abdominal obesity on disability and mortality among the older population in Purworejo district, Central Java Province, Indonesia.
**Theoretical framework**

In the age of globalisation, environmental circumstances and social factors play an essential role in health. Human health is not only determined by illnesses caused by microbes, toxins, nutrition, or lifestyle behaviours. Social and physical environments from early life, and working conditions, are associated with social stratification and also determine the exposure to the health risks that can cause illness. There are also many intermediate determinants of health. The WHO, through their Commission on Social Determinants of Health (CSDH), summarises the complexity of health determinants in the Social Determinants of Health framework (Figure 7) (79).

The CSDH framework illustrates how social, economic and political mechanisms influence socioeconomic positions, where the population is stratified by gender, race/ethnicity, income, education, occupation and other factors. These mechanisms that further generate stratification and social class are called ‘structural determinants’ or ‘social determinants’ of ‘health inequities.’ These structural determinants exert their influence through a set of intermediary determinants of health which include material circumstances, psychological circumstances and behavioural and biological factors (79).

![Figure 7. Social Determinants of Health framework (106).](image)

Improvements in medical technology have resulted in declining mortality rates among older adults. However, as people age, chronic NCDs tend to coexist (multimorbidity) together with a decline in physical strength. Thus, most of these older adults will live with multiple chronic conditions, which will lead to disabilities. Verbrugge and Jette
developed a model of disability called ‘The Disablement Process’ that is especially useful for epidemiological and clinical research (Figure 8) (107). This model describes the main pathway of the disablement process (pathology and its consequences), i.e. how chronic or acute conditions (pathology) affect body system functioning (impairments), physical and mental actions (functional limitations) and activities of daily life (disability). The model also describes how personal risk factors, intra-individual factors and environmental factors (extra-individual factors) will accelerate or decelerate the disablement process.

**Figure 8.** The Disablement Process (Verbrugge and Jette, 1994)
Conceptual framework of the thesis

This thesis adapts both the WHO’s CSDH (79) and Verbrugge and Jette’s model of the disablement process (Figure 9) (107). It combines both frameworks into one conceptual framework. Four sub-studies have been performed with the main outcome: the community perception (sub-study 1), abdominal obesity (sub-study 2), disability (sub-study 3) and mortality (sub-study 4).

The study on community perception (sub-study 1) explores the culture and societal values in the community together with the socioeconomic determinants belonging to the structural determinants of health. These socioeconomic determinants (gender, education, occupation and wealth index) will further influence the health outcome (i.e., abdominal obesity) through intermediary determinants (age, residence, marital status, lifestyle behaviours, and chronic conditions). Sub-study 2 of the thesis describes the socioeconomic inequalities in abdominal obesity and its contributing factors. This thesis further examines the impacts of having a small or large waist circumference on disability (sub study 3) and mortality (sub-study 4).

![Figure 9. Conceptual framework of the thesis](image-url)
INTRODUCTION

Aims
The overall aim of this thesis is to describe the pattern of socioeconomic and gender inequality in abdominal obesity and to analyse its impact on disability and all-cause mortality among older people in Indonesia.

Specific aims
1. To explore the community perceptions on type 2 diabetes mellitus and its risk factors (sub-study 1)
2. To describe socioeconomic inequalities in abdominal obesity and factors contributing to the inequalities (sub-study 2)
3. To examine the association between changes in waist circumference and disability and the influence of wealth status and abdominal obesity at baseline (sub-study 3)
4. To examine the association between waist circumference and the all-cause mortality and the influence of wealth status (sub-study 4)
Materials and Methods

Study context
The study was conducted in Purworejo District, Central Java Province, Indonesia (Figure 10). Purworejo is located on the southern part of Java Island, between Kebumen District on the West and Yogyakarta Province on the East.

In 2016, 712,686 residences inhabited an area of 1035 km². More than 84% of the area is agricultural land for food crops such as rice, maize, soybean, peanuts, cassava, sweet potatoes and green beans. About 90% of the Purworejo District is rural, while the remaining 10% consists of small urban settlements (Figure 11). In total, the district has 16 sub-districts and 494 villages (108).

Purworejo District has eight hospitals (one public and seven private), three maternity hospitals and twenty-seven primary health centres (108). In Purworejo, hypertension and diabetes type-2 are the leading NCDs, along with upper respiratory tract infection, diarrhoea and malaria as the leading communicable diseases (108).

Figure 10. Map of Central Java.
Source: https://explorekerinci.com/map-semarang-barat-central-java.html
MATERIALS AND METHODS

Figure 11. Different areas of Purworejo District (July 2018).

Study population

In 1994, a Health and Demographic Surveillance System (HDSS) site was established in Purworejo District as a collaboration between the Faculty of Medicine Gadjah Mada University, Ministry of Health of Indonesia, Purworejo District Health Office, the World Bank and United Nation Children’s Fund (UNICEF) (109). The HDSS covers 55,000 individuals living in 14,500 households. It collects demographic data (birth, death, marital status, migration, etc.) on an annual basis and household socioeconomic data every five years (109).

The HDSS sample was chosen through multistage cluster sampling with probability proportional to size, and with the enumeration area as the primary sampling unit. The HDSS constitutes 20% of the 793 enumeration areas in Purworejo District. The secondary sampling unit is the household. Approximately 110 households with all family members, were selected from each enumeration area. Routine visit to each household has been conducted since 1994 to collect data on household assets & socioeconomic data, in- or out-migration data, and verbal autopsy data (109, 110). The site became a member of the INDEPTH Network of HDSS sites in 1998 (111), and became a basis for many studies embedded in the surveillance site (110).
Study design
This thesis uses both qualitative and quantitative methods (Table 2). The qualitative study (sub-study 1) was conducted to understand the general community’s perception on chronic NCDs and accompanying risk factors, with a special focus on diabetes mellitus. We utilised focus group discussions (FGDs) due to their ability to reflect the group’s beliefs or perceptions. The FGDs were conducted during 2011-2012 in groups of men and women. We invited four to seven participants to each group. The participants were selected to represent different age groups (young: 20–34 years old; adult: 35–54 years old; old: 55+ years old).

The quantitative study (sub-study 2 to 4) utilised the data from the 1st and 2nd waves of the WHO-INDEPTH Study on global AGEing and adult health (SAGE) in Purworejo HDSS. The first wave was conducted in 2007 and the second wave in 2010 (112). The first wave included 11,753 individuals who were aged 50 years and older in 2007. In 2010, these individuals were followed up. A total of 4,714 new individuals aged 50 years and older were recruited into the 2nd wave in 2010. The studies data sources and participants included in this thesis are presented in Figure 12.

Household asset surveys were conducted in 2005 (covering 12,684 households) and in 2010 (covering 12,321 households). Data from the household asset surveys were used to be able to calculate the wealth index for each household. The wealth index was linked to the individual data using the unique household identification number, and then used further as a proxy for the SES status in this thesis.

The individual-level data in the first wave was linked with the wealth index from the household-level data in 2005, and the second wave was linked with the second household-level data in 2010.
Table 2. Overview of the study methods

<table>
<thead>
<tr>
<th>Sub-study</th>
<th>Aims</th>
<th>Study type</th>
<th>Study design</th>
<th>Data sources (Year)</th>
<th>Number of participants</th>
<th>Analytical approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To explore the community perceptions on type 2 diabetes mellitus and the risk factors</td>
<td>Qualitative</td>
<td>Purposive sampling</td>
<td>Focus group discussions (2011 &amp; 2012)</td>
<td>68</td>
<td>Content analysis</td>
</tr>
<tr>
<td>2</td>
<td>To describe socioeconomic inequalities in abdominal obesity and identify factors contributing to the inequalities</td>
<td>Quantitative</td>
<td>Cross-sectional study</td>
<td>WHO-INDEPTH SAGE (2010)</td>
<td>12,570</td>
<td>Concentration index and decomposition analysis</td>
</tr>
<tr>
<td>3</td>
<td>To examine the association between changes in waist circumference and disability and the influence of wealth status and abdominal obesity at baseline</td>
<td>Quantitative</td>
<td>Panel study</td>
<td>WHO-INDEPTH SAGE (2007 &amp; 2010)</td>
<td>8,089</td>
<td>Multivariate linear regression analysis</td>
</tr>
<tr>
<td>4</td>
<td>To examine the association between waist circumference and all-cause mortality and the influence of wealth status</td>
<td>Quantitative</td>
<td>Longitudinal study</td>
<td>WHO-INDEPTH SAGE (2007 &amp; 2010)</td>
<td>10,997</td>
<td>Multivariate Cox regression analysis with restricted cubic splines</td>
</tr>
</tbody>
</table>
Figure 12. Data sources and study participants.
Qualitative study (Sub-study 1)

Data collection

The participants were selected deliberately from six villages that represented different geographical areas, including highland (mountainous), lowland (coastal), and suburban areas (close to the district centre). We conducted two FGDs in each village (Table 3). To maximise the variation of the data and to facilitate a comfortable environment during the discussion, we purposefully stratified the groups by sex and age (young: 20-34, adult: 35-54, old: 55+ years old). The local research assistant and the village leader invited four to seven participants for each FGD based on the village leader’s knowledge regarding the participant’s willingness to discuss issues and participate in the FGD.

Table 3. Number of participants (sex and age) by villages in the focus group discussions.

<table>
<thead>
<tr>
<th>Participant age group (years)</th>
<th>Highland</th>
<th>Lowland</th>
<th>Satellite</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pakem</td>
<td>Keduren</td>
<td>Sokowaten</td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-34 y</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>35-54</td>
<td></td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>55+</td>
<td></td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-34</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>35-54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55+</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

Figure 13. Focus group discussions in Purworejo District.
Participants were invited to the village hall or to the house of a volunteering participant. The main researcher (CP) led all the FGDs in Indonesian and Javanese languages, assisted by a local research assistant who was a native Javanese speaker (Figure 13). All authors in the qualitative study were continuously involved in all stages of the study.

During the data collection, a co-author (ME) attended two FGDs (one men, one women) which enriched ME’s perspectives on the study setting, the participants, and the flow of the discussions (Figure 14). The first author (CP) conducted the qualitative content data analysis under ME’s supervision.

The FGD guide was developed in English and was translated into the Indonesian language (Table 4). The FGDs were divided into two sections, based on the content areas (i.e. perceptions about diabetes and perceptions about diabetes risk factors). Section one started with the open-ended question, “What have you heard about diabetes?” Participants were encouraged to express, share and discuss their opinions, perceptions, knowledge, and experiences of diabetes openly.

In section two, we utilised 12 picture cards showing the potential risk factors for diabetes mellitus as well as the false risk factor examples (Figure 15). The picture cards with risk factors are age; fast food; family history of diabetes; overweight/obesity; smoking; low physical activity; low fruit and vegetable intake; stress; race/ethnicity; and anti-hypertensive medication. The picture cards with false risk factor examples are x-rays and pets. Two or three risk factor cards were distributed to each participant, and they were asked, “What do you think about the pictures in the cards?” Participants were encouraged to give arguments as to whether the pictures were related to diabetes or not, and why. Other participants were also invited to argue or discuss their thoughts.
MATERIALS AND METHODS

The discussions lasted for approximately 60 to 90 minutes and were recorded using a digital voice recorder under the permission of the participants. We provided snacks during the discussions and a small monetary incentive for the participants at the end of the sessions as reimbursement for their time.

Table 4. Focus group discussion guide in English.

<table>
<thead>
<tr>
<th>Section one (diabetes in general)</th>
<th>Section two (diabetes risk factors)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What have you heard about diabetes? What kind of disease it is?</td>
<td>What do you think about the picture in the cards?</td>
</tr>
<tr>
<td>Is it dangerous to have diabetes?</td>
<td>Is that picture somehow related with diabetes?</td>
</tr>
<tr>
<td>Is diabetes common in your community? (Optional)</td>
<td>What in your opinion causes diabetes?</td>
</tr>
<tr>
<td>Is there anyone in your family that has diabetes? Would you like to share about it? (Optional)</td>
<td></td>
</tr>
<tr>
<td>How in your opinion would life be affected if you had diabetes? (Optional)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 15. Picture cards used in focus group discussions in English.
Data analysis

All the FGD records were transcribed in their original language (Bahasa Indonesia or Javanese). The native Javanese assistant translated all sections that were in Javanese into Bahasa Indonesia before the transcripts were analysed by the main researcher. The transcripts were analysed using content analysis (113). The analysis began by finding ‘meaning units’ in the transcribed text that were relevant to the research questions. These meaning units were then developed into ‘condensed meaning units’, and then coded. In the next step, the codes were clustered according to the two content areas. These two content areas were analysed separately.

In each content area, sub-categories were created according to issues that were repeatedly emphasised by the groups and by sorting codes due to their commonality. The sub-categories were further sorted into categories. In the last step, themes were created to link the underlying meanings within the categories. Results are presented according to content area. The audit trail example is shown in Table 5.

<table>
<thead>
<tr>
<th>Table 5. Example of an audit trail from text to code clusters.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content analysis</strong></td>
</tr>
<tr>
<td><strong>Meaning unit</strong></td>
</tr>
<tr>
<td><strong>Condensed meaning unit</strong></td>
</tr>
<tr>
<td><strong>Codes</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Codes cluster</strong></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Quantitative studies (Sub-study 2, 3 and 4)

Instruments

The individual WHO-INDEPTH SAGE and household-level asset survey questionnaires were used in the quantitative studies (114). Both questionnaires were translated into the Indonesian language, pilot-tested and translated back into English. The individual questionnaire contained information on respondents’ socio-demographic characteristics (i.e. age, education, occupation, marital status, residence), self-reported chronic conditions, and WHO Disability Assessment Schedule version 2.0 (WHODAS-II). Data on smoking habits were only available in the WHO-INDEPTH SAGE questionnaire in 2010. Therefore, the smoking variable was only included in sub-study 2. The list of variables and their operational definitions are presented in Table 6.

The WHODAS-II measures difficulties in daily physiological, personal and social functioning within six domains (115). We used the short version of WHODAS-II consists of 12 questions representing the six domains. The first three domains belong to the physiological functioning: cognition (ability to concentrate or learn a new task), mobility (ability to walking, prolonged standing and being able to stand up quickly after sitting down), and self-care (ability to perform daily living activities). The next two domains belong to the personal level of functioning: interpersonal interactions (ability to interact with other people and dealing with conflicts) and household activities (ability to perform day-to-day activities related to household chores). The last domain belongs to the social functioning of participation in society (whether one’s having difficulty in joining or taking part in community activities) (115).

Each of the questions asks the respondents “In the last 30 days, how much difficulty/problems did you have with...?” Responses to these questions were recorded on a 5-point Likert scale of ‘none’, ‘mild’, ‘moderate’, ‘severe’, and ‘extreme/cannot do’. The score was then computed in three steps: responses were recoded to a score with a weight ranging from 0 to 4 (step 1), the scores for all 12 questions were summed up to a total score ranging from 0 to 48 (step 2), and the total scores were rescaled to a metric score ranging from 0 to 100 (step 3) where 0 represents no disability and 100 represents full or extreme disability (115).

The questionnaire about household assets contained information on housing ownership and building condition (i.e. house ownership, floor, roof, wall materials), infrastructure facilities (i.e. source of water, cooking material), electronic equipment ownership (i.e. TV, refrigerator, telephone), kettle ownership, and ownership of assets (i.e. car, motorbike, bike). Assets which were owned by < 10% or > 90% of the households in the study population were excluded. The selected assets were then used in creating the ‘wealth index’, using principal component analysis (PCA) (116).
PCA created the wealth index for each household by generating a weight for each chosen asset and creating the index based on the sum of all asset weights included.

**Table 6.** Operational definitions of the variables in the WHO-INDEPTH SAGE in 2007 and 2010 included in the thesis.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories and definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist circumference</td>
<td>Measured in centimetres at the point midway between the last palpable rib and the top of iliac crest using a non-elastic measuring tape (56).</td>
</tr>
<tr>
<td>Changes in waist circumference</td>
<td>Calculated as the absolute change in centimetres between the two surveys. Negative value indicated decreases in waist circumference over time; positive value indicated increases in waist circumference over time.</td>
</tr>
<tr>
<td>Abdominal obesity</td>
<td>Without abdominal obesity: waist circumference &lt;90 cm for men or &lt;80 cm for women; With abdominal obesity: waist circumference ≥90 cm for men or ≥80 cm for women [34, 35].</td>
</tr>
<tr>
<td>Disability</td>
<td>Measured using the 12-question (short version) of WHODAS-II. The WHODAS-II score was ranging from 0 to 100, where 0 represents no disability and 100 represents full or extreme disability (115).</td>
</tr>
<tr>
<td>Deaths</td>
<td>Collected through Purworejo HDSS death report, defined as all-cause mortality.</td>
</tr>
<tr>
<td>Age group</td>
<td>50-59, 60-69, 70-79, 80+ years.</td>
</tr>
<tr>
<td>Education</td>
<td>No formal education: never having any formal education; ≤6 years: not completed elementary school, completed elementary school; &gt;6 years: completed junior high school, high school, academy or university, master’s degree.</td>
</tr>
<tr>
<td>Occupation</td>
<td>Non-physical labour: government worker, non-government worker, self-employed; Physical labour: farmer, fishermen, driver, rickshaw driver; No occupation: retired, housewife, not-having a job.</td>
</tr>
<tr>
<td>Marital status</td>
<td>Single/widowed: not married, divorced, separated, widowed; Partnership: married, living together.</td>
</tr>
<tr>
<td>Residence</td>
<td>Coastal, inland, hilly &amp; mountainous</td>
</tr>
<tr>
<td>Self-reported chronic disease</td>
<td>No: did not report having any chronic disease; Yes: reported having at least one (≥1) of the chronic conditions including hypertension, diabetes, stroke, CVD, chronic obstructive pulmonary disease (COPD), asthma, and cancer.</td>
</tr>
<tr>
<td>Wealth index</td>
<td>The index was categorised into quintiles in sub-study 2 (the 1st quintile represented the poorest group and the 5th quintile represented the richest group) and was divided in two (poor and rich) based on its median in sub-study 3 and 4.</td>
</tr>
<tr>
<td>Smoking status (only in 2010)</td>
<td>Non-current smokers: never smokers, ex-smokers; Current smokers: currently smoked daily or non-daily.</td>
</tr>
</tbody>
</table>
MATERIALS AND METHODS

Data collections
Prior to the initial data collection, the field workers participated in several training sessions. A total of 25 field surveyors performed face-to-face interviews under the supervision of four supervisors. Waist circumference was measured in centimetres after the interview was completed. The data was collected on forms, which were later scanned optically. We rechecked 10% of the data manually to ensure the accuracy of the optical readings. All data were saved in csv format, which was later exported into Stata files for further analyses.

Additional socio-demographic information including date of death, in-migration, and out-migration, was extracted from the Purworejo HDSS databases. Integration of WHO-INDEPTH SAGE study into a well-established HDSS allows for data linkage within longitudinal databases focused on population health and dynamics.

Data analysis
In sub-study 2, we estimated the concentration index to assess any inequality in abdominal obesity. The concentration index, ranging from -1 to +1, shows the distribution of abdominal obesity in the study population across the wealth index. A negative concentration index indicates that abdominal obesity is concentrated among the disadvantaged (poor/deprived) while a positive concentration index indicates that abdominal obesity is concentrated among the advantaged (rich/wealthy). When the concentration index is equal to zero, there is no inequality (117). The concentration curve ranks the population from the most-disadvantaged to the most-advantaged group on the x-axis. The y-axis indicates the cumulative percentage of abdominal obesity. The 45° diagonal line is called the line of equality (117).

To identify factors that contribute to inequality in abdominal obesity, an additional step of decomposition analysis was performed. This analysis decomposes the abdominal obesity concentration index into the ‘explained component’ and the ‘unexplained component’. The explained component produces the elasticity, the concentration index, and the contribution to the concentration index for each of the covariates. The unexplained component remains as ‘residual’, which reflects the inequality that cannot be explained by the covariates included in the decomposition analysis (117, 118).

An additional step of Wagstaff normalisation was required in the concentration index and decomposition analysis as the study used binary outcome variables, i.e. abdominal obesity (yes/no). This additional step ensured that the concentration index was quantified in the range of -1 and +1, by dividing the concentration index by 1 minus the mean (117, 119). Marginal effects from a probit regression were used in
the elasticity calculation to normalise the decomposition analysis (117). The affluent (advantaged) covariate was selected as the reference category.

The third and fourth sub-studies utilised panel and longitudinal data of the WHO-INDEPTH SAGE study, with baseline data from 2007 and follow-up data from 2010. In sub-study 3, we used multivariate linear regression analysis to assess the association between waist circumference and disability. Two multivariate linear regression models were estimated: the ‘baseline model’ and the ‘waist circumference change model’. The baseline model examined the association between waist circumference and disability scores in 2007, adjusted for all socio-demographic variables. The waist circumference change model examined the association between changes in waist circumference (2007-2010) and disability scores in 2010, adjusted for waist circumference, disability score, and socio-demographic variables at the baseline in 2007. Lastly, we presented a linear predicted plot by repeating the waist circumference change model analysis, stratified by sex, wealth status and the baseline abdominal obesity categories.

The fourth sub-study used multivariate Cox regression analysis to estimate the hazard ratios (HR) of the association between waist circumference and all-cause mortality. We estimated time-to-event in person-months, using the date of interview in the baseline through the date of death during 2007-2010. Individuals who were followed-up in 2010, or outmigration, or lost-to-follow-up were censored in the analysis.

The association between obesity and mortality is non-linear in nature (120). To decide whether waist circumference should be modelled as linear or non-linear in the multivariable Cox regression analysis for mortality, we compared the Akaike Information Criterion (AIC) values (data not shown). All the models were adjusted for: sex, age group, marital status, education, occupation, residence, self-reported chronic disease and wealth status. We ran the linear and non-linear model for both full and stratified analyses by sex and wealth status. The non-linear relationships between waist circumference and all-cause mortality were modelled using restricted cubic splines analysis, with 4 degrees of freedom (121). The non-linear model showed the lowest AIC score. Therefore, we decided to use the restricted cubic splines of waist circumference to model the non-linear relationship between waist circumference and the hazard ratios for all-cause mortality.

The Cox regression analyses with restricted cubic splines were conducted separately in: 1) poor men, and 2) rich men, 3) poor women, and 4) rich women. These analyses were performed by adjusting for the remaining variables (i.e., age group, marital status, education, occupation, residence, self-reported chronic disease). The estimated HR in every 1 cm increase of waist circumference were
presented graphically with 95% confidence interval (CI) bands across the whole waist circumference range, where risks were relative to the reference value for each sex. The reference values (men = 90 cm, women = 80 cm) were based on the abdominal obesity cut-off value for Asian populations.

All statistical analyses were performed using Stata Version 13. We used R version 3.4.4 to plot the estimated HR and 95% CI in sub-study 4. For all analyses, $p < 0.05$ (two-tailed) was taken as the threshold for statistical significance which corresponds to the 95% confidence interval.

**Ethical considerations**

The ethical board of the Faculty of Medicine, Gadjah Mada University, Indonesia, reviewed and granted the ethical approval for both the qualitative and quantitative studies (IRB number: KE/FK/69/EC). Information about the study was provided to each participant verbally, prior to the data collection, followed by the obtaining of written informed consent. The participants were also informed that they could withdraw from the study at any stage.
Results

The results section presents a summary of the main findings from the four substudies. First, it begins by presenting findings from the qualitative study (sub-study 1) in an attempt to understand how the general community views chronic NCD and its risk factors, using diabetes mellitus as an example. Second, the characteristics of the respondents that were recruited and consequently included in the quantitative studies are presented. Third to be presented are the findings from sub-study 2, showing the inequalities in abdominal obesity and the contributors to the inequalities. Fourth, findings from sub-study 3 on the effects of changes in waist circumference on disability are presented. Finally, the impact of waist circumference on mortality is presented, as taken from sub-study 4.

Community perception on chronic disease and risk factors (Sub-study 1)

A total of 68 participants aged 20-82 years old, with an equal number of men and women, participated in the 12 FGDs. Thirteen (4 men and 9 women) out of the 68 participants reported that they had at least one family member diagnosed with diabetes. The FGDs revealed two themes that were present in both content areas: these were 1) perceptions about diabetes and 2) perceptions about diabetes risk factors. The themes emerged based on the identified categories that are shown in Table 7 below.

Table 7. Themes and categories in each content area.

<table>
<thead>
<tr>
<th>Content area</th>
<th>Diabetes</th>
<th>Diabetes risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Themes</td>
<td>A visible and scary sugar disease that can be blamed on modern lifestyle</td>
<td>Unrealistic optimism in diabetes risk factor perception</td>
</tr>
<tr>
<td>Categories</td>
<td>A ‘dry’ and ‘wet’ sugar disease</td>
<td>Heredity and sugar are the main risk</td>
</tr>
<tr>
<td></td>
<td>A visible disease</td>
<td>‘Modern’ lifestyle is a risk</td>
</tr>
<tr>
<td></td>
<td>A silent disease with ‘terrifying’ effects</td>
<td>Older age increases risk</td>
</tr>
<tr>
<td></td>
<td>A disease with no cure</td>
<td>Ambiguity in smoking risk</td>
</tr>
<tr>
<td></td>
<td>A disease for ‘the wealthy’</td>
<td></td>
</tr>
</tbody>
</table>
Community perceptions about diabetes

The community viewed diabetes as ‘a visible and scary sugar disease that can be blamed on modern lifestyles’. First of all, most participants were not familiar with the term ‘diabetes’. They used the terms ‘sugar disease’ or ‘sweet-pee disease’ instead of ‘diabetes’. These terms were used by them to refer to the cause (sugar) and the symptoms (sweet-pee) of diabetes. They also mentioned that they thought the ‘sweet-pee disease’ to be an early stage that develops into ‘sugar disease’: that is, when the diabetic wounds manifested themselves. The community classified ‘sugar disease’ into ‘wet sugar’ and ‘dry sugar’ disease according to the type of wound the disease cause. They defined the ‘wet sugar disease’ as ‘having watery wounds that are difficult to heal’, and the ‘dry sugar disease’ as ‘those who lose weight and become skinny’.

“(To prevent sugar disease) I should reduce sugar by not eating too much rice because its sweet, all food contains sugar we should avoid” (Women – old)

“Some said that if the pee... the pee was shrouded by ants, it means diabetes symptom, or maybe, he already gets one” (Men – old)

Even though most participants were not familiar with the term ‘diabetes’, they were aware of the existence of diabetes by recognising the wounds it caused. Participants seemed to have become accustomed to the existence of diabetes in their neighbourhood and this might have lowered their awareness or preventative measures. Nevertheless, the effects of diabetes such as open unhealed wounds, amputation, complications, and death still terrified them. In all FGDs, participants consistently focused on these terrifying effects. Diabetes was viewed as a disease with ‘no way out except death’. They just agreed that ‘if someone has sugar disease, they must be prepared for death’.

One important finding is that the community viewed a chronic NCD such as diabetes as a disease for ‘the wealthy’. They described wealthy people as being physically inactive because of their more sedentary nature of work. They mentioned that the wealthy could afford to hire a maid for housework. The participants also related being wealthy with having plentiful and wide-ranging foods constantly available and connected this to the onset of diabetes. Participants argued that wealthy people are ‘greedy’.
“We haven’t heard of any poor people having sugar disease, it’s usually those in the middle and upper-class. Maybe... wealthy people eat tasty food but don’t want to work... so their laziness (lack of activity) will cause sugar disease” (Women – young group)

“Most diabetics are usually lazy... their activity does not produce sweat... not like us farmers... we sweat a lot”. “Yeaaa ... those who work with less energy ... just like him ... (referring to one of the diabetic participants) ... he does not work like us ... that’s what we see” (Men – adult)

“Her weight was 65kg! (Referring to one diabetic participant) She used to eat a lot... hahaha (laughing). We as her neighbours know that in her family the eating habit was amazing! They eat whatever they want; they (can afford to) buy fish, chicken, meat...anything they like... she likes to eat ‘Gule’ (a slow cooked meat with curry and coconut milk gravy) and only a little vegetable... so all the neighbours assume that she is sick because of her ‘big’ eating habit...” (Women – adult)

The participants were of the opinion that the chronic nature of diabetes meant that it required daily treatments and management that were expensive. This meant that the disease was seen as needing long-term, high-cost attention which places a burden on all of the family members and makes poor people feel helpless about it. The wealthy were perceived as having the ability to cope with diabetes treatments. The poor did not have sufficient resources to obtain the required medication and care. The participants agreed among themselves that wealthy diabetics had the chance of living a long life, whereas the poor with the disease had to be prepared to die.

“My mother was a diabetic, when we still had money we gave her medication, but after a while we ran out of money, then... She died... They (refer to medical practitioner) still do not have a cure for diabetes...” (Women – old)

“He (a diabetic) has money...that means he can afford to buy injections, so he has a long life, but for people who don’t have money, the disease becomes severe...If we do not have money, then we will die very soon” (Women – old)
Community perceptions about diabetes risk factors

In the second content area relating to the perception of diabetes risk factors, an ‘unrealistic optimism in diabetes risk factors perception’ was identified as a theme. This theme was developed based on four categories.

‘Heredity’ and ‘sugar’ were well recognised as the main risk factors for diabetes. The community believed that inheritable factors were necessary to get diabetes, with the logical conclusion that those of them without a family history of diabetes will never develop it. At the same time, referring to its name ‘sugar disease’, the community also believed that a high consumption of sugar would cause diabetes.

“If the grandparents had diabetes, the kids or grandchildren will also have diabetes” (Men – old)

‘Modern lifestyle’ was also believed to be a diabetes risk factor. The FGDs agreed that most diabetics were fat, lazy, and eat tasty food that included large quantities of meat. As villagers who were engaged in farming activities who could not afford the tasty food, they believed that they were spared from diabetes. They argued that the ones at risk were ‘the wealthy’ because they weren’t farmers, and because only the wealthy could afford the modern lifestyle.

The older group mentioned that the younger generations were living a more modern life and becoming used to consuming fast food which was making them prone to the disease. The older participants were aware that being older meant that they have to be cautious about their health, however, they believed that they could be protected from the disease because they still held to their traditional lifestyle by eating mainly vegetables that are grown without any pesticides and cooked with pure herbs. In the meantime, the younger age group believed that they were ‘immune’ to diabetes because of their youth.

“This (modern) young generation seems to be more careful in terms of food but are somehow more likely to consume instant food and use instant seasoning on food”.

“The older generations do not know pesticides, preserved food, or preservatives... nowadays there are a lot of preservatives in the food...”” (Women – old)

“Older people, especially those who are fat, get sugar disease more easily... It is not possible for me to have diabetes... because I am young... hehehe (laughing)” (Men – young)
All men, both smokers and non-smokers, who participated in this study disagreed that smoking was a risk factor for diabetes. They believed that smoking was only related to heart disease (i.e. CVD), lung disease (i.e. COPD or lung cancer), or pregnancy disorders as mentioned on the cigarette packaging. The smokers strongly argued that smoking had health benefits as they compared their health status to other men who did not smoke. They believed that they had better health compared to the non-smokers. The smokers in some of the groups stated that ‘it is better not to eat than not to smoke’.

“I am 74-year-old, and I eat everything I want, I never restrict my food, and I am healthy. Include smoking, I smoked since elementary school, I never even cough”
(Men - old)

Women, on the other hand, strongly disagreed about the positive effects of smoking and were aware about the health consequences of smoking, including diabetes. They stated that they had never and would never try smoking. Smoking was viewed as a ‘manly’ activity that excluded women. On the other hand, women participants mentioned that they were worried by, and also felt helpless in, viewing their spouse’s or family member’s smoking behaviours.

“I think...the smokers are having higher risk, the possibility of eee (pause)... the person chance of having diabetes is greater than those who do not smoke”
(Women – old)

“Men earn their money, so they can spend their money on smoking”
“Our husbands are heavy smokers and it is difficult... (to stop them)”
(Women – young)
Characteristics of subjects in the quantitative studies

Sub-study 2 uses the WHO-INDEPTH SAGE cross-sectional data in 2010 (Table 8). A total of 14,235 individuals aged 50 years and older were recruited. The WHO-INDEPTH SAGE individual level data was linked with the household level data in 2010. We successfully linked 13,941 individuals living in 9,302 households and excluded 294 individuals with missing household data. Due to incomplete data on key variables, we then excluded a further 1,371 individuals, thus 12,570 remained for further analysis.

Sub-study 3 uses the WHO-INDEPTH SAGE panel data in 2007-2010. A total of 11,753 individuals aged 50 years and older were recruited in 2007. At the follow-up in 2010, 1,199 had died and 1,033 were lost for follow-up and were excluded. Due to incomplete data on the key variables, we excluded a further 1,432 individuals, leaving 8,089 for analysis.

Sub-study 4 uses the WHO-INDEPTH SAGE longitudinal data in 2007-2010. A total of 11,753 individuals aged 50 years and older were recruited in 2007 and were followed up in 2010. Among these, 756 were excluded due to missing dates of death and incomplete data. A total of 10,997 data were used in the analysis for sub-study 4.

Overall, the majority of men and women had less than 6 years of education and were engaged in physical labour, in partnerships and living in coastal areas. The percentage of single and widowed people was higher among women. The prevalence of chronic NCDs and abdominal obesity was also higher in women than in men.
Table 8. Number and percentage (%) of men and women recruited and included in the sub-study by socio-economic characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Sub-study 2 Cross-sectional Year 2010</th>
<th>Sub-study 3 Panel Year 2007-2010</th>
<th>Sub-study 4 Longitudinal Year 2007-2010</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>Respondents recruited</td>
<td>14,235</td>
<td>11,753</td>
<td>11,753</td>
</tr>
<tr>
<td>Excluded</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date of death not available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lost to follow-up</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household data not available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incomplete data</td>
<td>1,371</td>
<td>1,432</td>
<td>604</td>
</tr>
<tr>
<td>Respondents analysed</td>
<td>12,570</td>
<td>8,089</td>
<td>10,997</td>
</tr>
<tr>
<td>Respondents analysed (%)</td>
<td>5,782 (46)</td>
<td>6,788 (54)</td>
<td>3,798 (47)</td>
</tr>
<tr>
<td>Age (years) (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>2,492 (43)</td>
<td>2,760 (41)</td>
<td>1,561 (41)</td>
</tr>
<tr>
<td>60-69</td>
<td>1,554 (27)</td>
<td>1,936 (28)</td>
<td>1,298 (34)</td>
</tr>
<tr>
<td>70-79</td>
<td>1,278 (22)</td>
<td>1,559 (23)</td>
<td>772 (21)</td>
</tr>
<tr>
<td>80+</td>
<td>458 (8.0)</td>
<td>533 (8.0)</td>
<td>167 (4.0)</td>
</tr>
<tr>
<td>Education (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education</td>
<td>616 (11)</td>
<td>2,112 (31)</td>
<td>543 (14)</td>
</tr>
<tr>
<td>≤6 years</td>
<td>3,750 (65)</td>
<td>3,852 (57)</td>
<td>2,430 (64)</td>
</tr>
<tr>
<td>&gt;6 years</td>
<td>1,416 (24)</td>
<td>824 (12)</td>
<td>825 (22)</td>
</tr>
<tr>
<td>Occupation (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-physical labour</td>
<td>586 (10)</td>
<td>662 (10)</td>
<td>359 (9.0)</td>
</tr>
<tr>
<td>No occupation</td>
<td>923 (16)</td>
<td>2,776 (41)</td>
<td>405 (11)</td>
</tr>
<tr>
<td>Physical labour</td>
<td>4,273 (74)</td>
<td>3,350 (49)</td>
<td>3,034 (80)</td>
</tr>
<tr>
<td>Marital status (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single/widowed</td>
<td>735 (13)</td>
<td>2,745 (40)</td>
<td>414 (11)</td>
</tr>
<tr>
<td>Partnership</td>
<td>5,047 (87)</td>
<td>4,043 (60)</td>
<td>3,384 (89)</td>
</tr>
<tr>
<td>Residence (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coastal</td>
<td>2,877 (50)</td>
<td>3,381 (50)</td>
<td>1,918 (51)</td>
</tr>
<tr>
<td>Inland</td>
<td>1,385 (24)</td>
<td>1,713 (25)</td>
<td>881 (23)</td>
</tr>
<tr>
<td>Hilly &amp; mountainous</td>
<td>1,520 (26)</td>
<td>1,694 (25)</td>
<td>999 (26)</td>
</tr>
<tr>
<td>Self-reported chronic disease (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>4,504 (78)</td>
<td>4,801 (71)</td>
<td>3,243 (85)</td>
</tr>
<tr>
<td>Yes</td>
<td>1,278 (22)</td>
<td>1,987 (29)</td>
<td>555 (15)</td>
</tr>
<tr>
<td>Wealth index (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st quintile (poorest)</td>
<td>1,077 (19)</td>
<td>1,449 (21)</td>
<td>679 (18)</td>
</tr>
<tr>
<td>2nd</td>
<td>1,128 (19)</td>
<td>1,371 (20)</td>
<td>762 (20)</td>
</tr>
<tr>
<td>3rd</td>
<td>1,157 (20)</td>
<td>1,330 (20)</td>
<td>804 (21)</td>
</tr>
<tr>
<td>4th</td>
<td>1,218 (21)</td>
<td>1,314 (19)</td>
<td>853 (22)</td>
</tr>
<tr>
<td>5th quintile (richest)</td>
<td>1,202 (21)</td>
<td>1,324 (20)</td>
<td>700 (18)</td>
</tr>
<tr>
<td>Abdominal obesity (%)</td>
<td>358 (6.2)</td>
<td>2,042 (30)</td>
<td>207 (5.4)</td>
</tr>
</tbody>
</table>

Notes: Abdominal obesity: waist circumference ≥ 90 cm for men and ≥ 80 cm for women [34, 35].

43
Abdominal obesity: a problem for the rich (Sub-study 2)

The concentration index of abdominal obesity was positive for both men (concentration index = 0.49, standard error (SE) = 0.04, p<0.001) and women (concentration index = 0.26, SE = 0.02, p<0.001) (Figure 16). The concentration curves with dashed lines below the line of equality indicate that abdominal obesity was not equally distributed across the wealth index but concentrated more among the advantaged (rich) population in both sexes. A lower concentration index value among women indicated less inequality observed among women compared to men.

**Figure 16.** Abdominal obesity concentration curve by sex.

The major contributing factors for socioeconomic inequality in abdominal obesity (Figure 17) among men were occupation (46.6%), wealth index (29.4%) and education (18.8%). Among women the major contributing factors were wealth index (44.7%), education (15.9%) and occupation (14.9%). Overall, the socioeconomic inequality in abdominal obesity in Purworejo district was explained by the covariates included in the study, confirmed by the small residuals in men (-0.093) and women (0.016).
Figure 17. Contributions of risk factors to the concentration index in abdominal obesity by sex.
RESULTS

Disability: effects of increasing waist circumference (Sub-study 3)

Figure 18 shows the regression coefficients of the multivariate linear regression analysis in the baseline and waist circumference model. The baseline model shows that for every 1 cm increase in waist circumference, a higher disability score by 0.066 units was observed (95% CI = 0.032, 0.10), holding all other variables constant. The disability score was significantly higher among women compared to men and it increased substantially with age. Disability score was higher among those with lower education, without occupation, those who were single/widowed, living in inland areas, having chronic diseases, and being poor.

Note: WC = Waist circumference, ChD = Chronic disease; Baseline model (cross sectional): WHODAS-II score in 2007 as the dependent variable regressed on baseline waist circumference and socio-demographic variables in 2007; Waist circumference change model: WHODAS-II score in 2010 as the dependent variable regressed on waist circumference change during 2007-2010, baseline waist circumference and disability score and socio-demographic variables in 2007.

Figure 18. Multivariate linear regression analysis regression coefficients in the baseline and waist circumference change models.

The waist circumference change model (Figure 18) shows that for every cm increase in waist circumference change, 0.094 units increase in the disability score was observed (95% CI = 0.051, 0.13), holding all other variables constant. Being a woman, being older, having a lower standard of education, taking part in non-physical labour...
or being unemployed, being single/widowed, living in inland, hilly & mountainous areas, having chronic diseases and being poor were significantly associated with increases in the disability score.

![Figure 19](image-url). Linear predicted disability score associations with changes in waist circumference (centered to zero), stratified by wealth status and abdominal obesity in men and women.

An increase in waist circumference is followed by increased disability: conversely, a decrease in waist circumference is followed by decreased disability (Figure 19). This association is significant among the poor non-obese men ($\beta = 0.12; 95\% \text{ CI} = 0.00038, 0.23$) and poor and rich obese women ($\beta = 0.17; 95\% \text{ CI} = 0.028, 0.30$ and $\beta = 0.16; 95\% \text{ CI} = 0.052, 0.27$, respectively).

Changes in waist circumference (either an increase or decrease) among the obese had a larger effect on disability, as is shown by the steeper regression slope. Comparing the plot of men and women shows that women have more disabilities than men, as the predicted score of disability was higher among women. Among the non-obese women, a decrease in waist circumference was associated with having more disabilities: conversely, an increase in waist circumference meant fewer disabilities. This underlined the importance of maintaining waist circumference, especially the poor women.
RESULTS

Mortality: obesity paradox among the poor (Sub-study 4)

A total of 5,129 men and 5,868 women were included in sub-study 4 of which 511 men and 470 women died during 3-years follow-up, with death rates of 99 and 80 per 1000, respectively. Men had higher death rate compared to women, and the poor had a higher death rate compared to the rich in both sexes (107 vs. 92 and 86 vs. 74, per 1000, in men and women respectively).

Note: Reference values: men = 90 cm, women = 80 cm

Figure 20. All-cause mortality hazard ratios (HRs) and 95% CI (shaded regions) according to waist circumference for poor and rich men and women.

Almost all plots showed wide confidence intervals (Figure 20). Poor men with waist circumferences of < 90 cm had a non-significant increase in the hazard ratio, while poor men with waist circumferences of > 90 cm had a non-significant decrease in the hazard ratio. There was no association between waist circumference and all-cause mortality in rich men.
RESULTS

There was a tendency towards a U-shaped association with waist circumference and all-mortality in poor women. Poor women with a waist circumference < 80 cm had an increased hazard ratio (significant for waist circumference in the range 62-73 cm), while poor women with a waist circumference > 80 cm had a decreased hazard ratio. However, the increasing slope among poor women from waist circumference > 80 cm upwards might indicate a tendency towards an increased mortality hazard.

For rich women, a U-shaped association between waist circumference and mortality was clearly shown, regardless of its wide confidence interval. Increasing mortality hazard was observed among wealthy women in the lower and upper ranges of waist circumference measurements.

Note: ChD = Chronic disease; HR = Hazard ratio; CI = Confidence interval

**Figure 21.** Covariates in the multivariate Cox regression analysis of all-cause mortality stratified by sex and wealth status.

Overall, the hazard ratios increased by age (Figure 21). The hazard ratios were significantly higher among poor and rich women with no occupation (HR = 3.9; 95% CI = 1.4, 10 and HR = 2.0; 95% CI = 1.1, 3.8, respectively), women and men with chronic disease, single/widowed rich women (HR = 1.6; 95% CI = 1.2, 2.2) and poor men who lived in the inland areas (HR = 1.6; 95% CI = 1.2, 2.1).
Discussion

Understanding the social determinants of health among older people is essential not only to those who comprise the age group, but also to society in general. This information will help to identify those factors that contribute to or cause health problems, as well as help with plans for the promotion of health and the formulating of the health policies that are needed. Given the progress of the epidemiological transition in Indonesia (80, 90), study on obesity among older adults is important. However, data on the patterns of socioeconomic and gender inequality in obesity, as well as obesity’s impact on disability and mortality among the older populations are relatively limited, especially in Indonesia.

This thesis is among the few longitudinal population-based studies conducted in Indonesia on abdominal obesity and its consequences among older adults aged 50 years and older. The remainder of this thesis will present the discussion based on the main findings.

Abdominal obesity: is it a problem for older people in Indonesia?

The process of ageing is complex. Older people become more vulnerable to sickness as their immune systems and organ capacities begin to decline (2, 3). The process of ageing involves not only the loss of, or decline in, physiological function, but it also involves changes in body composition (122, 123). In older people, intracellular water, lean body mass, and bone mass is lost whereas the proportion of fat increases (122, 123). The changes in body composition among older adults are therefore often accompanied with a gain in adipose tissue (3, 123).

As people get older, their diets need to be adjusted (122, 124). Older people need to lower their total calories per day (low carbohydrates, fat and sugar), but need to consume higher protein and calcium along with sufficient amounts of fruits and vegetables (122). They may also need to take regular vitamin supplements to offset the depletion of the nutrients in their body (124). However, many older people do not change their diets (122). They eat poorly balanced meals, unless advised otherwise by a medical doctor after deteriorating health is noted (124).

Studies show that due to alterations in carbohydrate and glucose metabolism at older ages, obesity does result, and it is closely associated with CVD (125) and diabetes (125, 126). Our qualitative study in the Indonesian setting showed that the community there believed that obesity was related to chronic NCDs (i.e. diabetes mellitus), and that it was most likely caused by eating behaviour. The FGD participants mentioned that being ‘greedy’ with food, where a person eats as much and as often as they like, will lead to diabetes.
In the FGDs, we also discussed age as a risk factor for diabetes. The younger participants believed that the risk of getting diabetes is increased with age. The older participants, however, did not agree. The older participants believed that they would be protected from diabetes due to their low body weight, rural working lifestyle such as farming, restrained and healthy eating behaviour, poor socioeconomic conditions, and absence of a family history of the disease. They argued that it is more likely that the younger generation will be at a higher risk of getting the disease because they often eat unhealthy food.

The community in our study were ‘unrealistically optimistic’ in perceiving the risk to them of developing diabetes. ‘Unrealistic optimism’, also known as ‘optimistic bias’, has been frequently discussed in health psychology studies of risk perceptions. The risk perceptions concept attempts to explain how people will repeatedly fail to prevent the onset of a disease just because they assume it will occur among others, but not themselves (127).

Our study shows high abdominal obesity rates among the older age groups, especially among women, along with a high level of self-reported chronic disease. In the national levels, the RISKESDAS shows high abdominal obesity rates among those at older ages, and that its prevalence increases between 2007 and 2013 (97). This indicates that abdominal obesity is a growing problem not only for older people in Purworejo but also in Indonesia as a whole.

**Socioeconomic inequality in abdominal obesity**

Socioeconomic position is one of the most important determinants of health (71). Higher socioeconomic position is associated with better health and a longer life (67, 70). In most HICs, obesity is more prevalent among poorer groups of people (74, 75). A recent study focusing on inequalities in overweight and obesity in 11 OECD countries showed that pro-rich inequalities (the poorer the more obese) exists in these countries, and that the inequalities have remained stable in the last 15 years (74). In contrast, studies conducted in LMICs showed that obesity was more prevalent among the richer groups (15, 76, 95, 128).

Our study found that abdominal obesity was concentrated more among the affluent group. This finding is in line with a recent study on socioeconomic inequality in overweight and obesity in Indonesia. Aizawa et. al. reported that the proportions of overweight and obesity in Indonesia increased rapidly during the period 1993 to 2004, with overweight and obesity remaining concentrated among the affluent (102). Another studies in Indonesia have shown that obesity is more prevalent among the wealthy group (30, 32, 77, 102).
The socioeconomic inequality in abdominal obesity that is reported in our study may be partly explained by economic and nutrition transition in Indonesia. The economic transition in Indonesia triggered the nutrition transition, with its changing diet patterns: from traditional healthier staple foods to energy-dense foods (30, 129, 130). Popkin et al. have explored and documented ample evidence regarding dietary changes in LMICs (13-15). The diets have all moved towards the higher consumption of refined carbohydrates, added sugars, fats and animal-source foods as well as a lower intake of vegetables (13-15). Studies have showed that the higher obesity prevalence within its rich groups is due to changes in food consumption patterns (15, 96). A recent literature review on consumption levels in Indonesia showed that the rich consume more sugar and carbohydrates compared to the poor (131). The poor, on the other hand, might have limited food choice and less of it, resulting in lower obesity rates (102).

The participants in the FGDs mentioned that it is the wealthy who would have a disease such as diabetes, because they have better access and affordability to food. Excessive intake of food, often foods with a high calorific value, was mentioned by the FGD participants to be the reason why the wealthy in their neighbourhood were developing obesity, which then leads on to chronic NCDs such as diabetes.

Nevertheless, although obesity is considered a disease of affluence in LMICs, obesity is no longer confined to the wealthy. A recent longitudinal study on socioeconomic inequality in overweight (BMI ≥ 25 kg/m²) and obesity (BMI ≥ 30 kg/m²) among Indonesian men and women aged 20+ years old showed that the concentration curve has shifted slowly each year towards the less affluent groups during the study periods of 1993, 1997, 2000, 2007, and 2014 (102). Decreases in concentration index were shown for both sexes but were consistently lower among women, indicating that obesity is rapidly becoming the problem of poor women (102). The Malaysian National Health and Morbidity Surveys on socioeconomic trends in overweight, obesity and abdominal obesity among adults aged 30 years and above also observed a shifted trend. They concluded that increasing risk of overweight and obesity is expected among the socioeconomically less advantaged (132). The overall shift in the obesity burden from the rich to the poor has been observed in systematic reviews of LMICs. The researchers also observed that the shift occurred faster among women than among men (95).
**Abdominal obesity impacts on disability and mortality: the role of socioeconomic position**

The association between a higher socioeconomic position and better health and longevity has been well recognised (67, 70). In this thesis abdominal obesity was more prevalent in the affluent groups; however, the poor were more disabled. In line with the latter finding, cross-sectional study conducted among older adults aged 60+ in China and India showed that the poor had a higher prevalence of physical impairment, functional limitations, and disability (133). Another longitudinal study on waist circumference and disability among older adults aged 65+ in Switzerland also found higher disability risks among those with financial difficulties (134).

In this thesis, the poor tended to have a larger decrease in waist circumference than their wealthier counterparts. Apart from in the case of non-obese women, an increase in waist circumference is also associated with increasing disability. Furthermore, in both sexes, disability was higher among the poor. The impact of waist circumference changes on the onset of disability is shown to be influenced by abdominal obesity and socioeconomic status.

This thesis also found that mortality risk in the lower end of waist circumference measurements was notably higher among the poor than it was among their wealthier counterparts. This led to a hypothesis that older adults with low waist circumferences are those who live with poor nutrition and poor health. Thus, health care cost is often unaffordable for the poorer group while most of the rich, with their better financial ability, have open access to proper health care, and are more likely to benefit from early detection and the proper management of the disease (135). This was mentioned in our FGDs, where the community stated that ‘the wealthy have a chance to live longer because they have sufficient resource to obtain the diabetes medications and care’.

On the contrary, a higher mortality risk in the higher end of waist circumference measurements was observed among the rich, while the poor with high waist circumferences were experiencing lower mortality. Findings where the mortality risk is lower among older adults with overweight or obesity, namely the ‘obesity paradox’, has been reported in many other studies (34, 136, 137). These studies have shown that a ‘moderate overweight’ may provide energy reserves during illness, especially among the older and poorer populations (124, 138, 139).

**Gender inequality in abdominal obesity**

In this thesis, a disparity was observed in abdominal obesity prevalence between men and women. A recent literature review on overweight and obesity prevalence studies in Indonesia has confirmed a similar result (77). The review reported that studies in
adolescent and adult age groups show higher obesity rates among women in Indonesia (77). Unlike in most HICs, the prevalence of obesity was higher among women in most LMICs (25, 26, 74, 95).

The gender disparities and related sociocultural factors could explain the difference in abdominal obesity prevalence between men and women. WHO defines gender as “the socially constructed roles, behaviours, activities and attributes that a given society considers appropriate for men and women” (140). Depending on their sociocultural condition, men and women have different roles, behaviours and activities in their daily life that were considered appropriate by their society (140). Thus, men and women have different exposures to risk factors and socioeconomic conditions, all of which may lead to unequal health outcomes (79, 140).

One example of socially constructed behaviour is reflected in how men and women in our study have a very different view of smoking. In our FGDs, women mentioned that they avoid smoking because it is culturally not acceptable for them. Our women participants viewed smoking as a manly activity and only allowed for men. They believed that a smoking woman would be viewed as ‘not a good woman’. This statement was confirmed in our sub-study 2, where the prevalence of current smokers are much lower among women compared to men (3.2% vs. 75%) (141). Furthermore, women feel helpless about their spouse’s smoking behaviour. They expressed a strong disagreement with their spouse’s smoking behaviour but ‘it is too difficult to stop the husband’. The women’s groups mentioned that because the men earn the money, they have the right to spend their money on cigarettes.

Studies show that the current smokers had lower BMI and lower probability of obesity compared to the non-smokers (142, 143). Nevertheless, smoking increases the risk of CVD, cancer and respiratory diseases (144, 145). Our study revealed that the dangers of smoking are not well understood. Although both men and women were aware that smoking is bad for health, as they read the warnings on the cigarette pack, men choose to ignore it. Interestingly, they also believed and defended the notion that smoking has positive health benefits. The smoking men even argued that their health is better compared to the non-smokers. Moreover, men, including the non-smokers, stated that smoking was not a risk factor for diabetes. A study about smoking cessation among men in diabetes clinics in Yogyakarta Indonesia also reported that more than 60% of the study participants believed that there is no association between diabetes and smoking, and that smoking does not aggravate diabetes (146).

A study of physical activity conducted among adults aged 25-64 years old in nine Asian INDEPTH HDSS, including Purworejo Indonesia, showed that women had lower level of physical activity than men. The study also showed that physical inactivity was
DISCUSSION

more prevalent among the youngest (25-34 years) and oldest (55-64 years) age groups (147). The majority of men in our study have a physical labour job (blue-collar workers), such as farmer, fisherman, and rickshaw driver. Even though the majority of the women population in our study has a physical labour job, there are tasks that women do not usually perform. Women in our study rarely do heavy manual labour such as hoeing the rice fields or pulling the carts, although they might plant the paddy field or harvesting the rice instead. In our study setting, old men continued their laborious work as farmers beyond pensionable age, while most of the older women acted as homemakers using less vigorous physical activity compared to their male counterparts.

At the same time, developments in technology also promoted a more sedentary life with the resulting lower physical activity levels (15, 30, 95, 131); furthermore, these had a greater impact among women (148). The second largest proportion of women in this study were housewives (i.e., no occupation). Therefore, developments in the technologies behind household appliances have rendered household chores less laborious and less physically demanding. These household appliances are now widely available and affordable (99). The increased use of motorised private transportation also leads to less energy expended during transfers from one place to another (99, 149). For example, women used to walk when they needed to buy groceries at a traditional market, nowadays they prefer to use motorbikes.

Social relationships such as marriage might be related to gender inequalities in abdominal obesity. A number of studies showed that marriage was associated with obesity (30, 77, 99, 150). In our study, abdominal obesity prevalence was higher among those in partnerships compared to those single/widowed. The mechanisms behind marital status and obesity are not fully understood. One possible mechanism in elucidating the effects of marital status and obesity was social obligations within marriage. Meals with richer and denser food will be served regularly as part of those traditional obligations (151). It can be hypothesised that older couples might have more regular meals, thereby contributing to the prevalence of larger waist measurements among married couples.

In Indonesia, it is women’s responsibility to prepare and serve food in the house. Although men can cook a simple meal, few men ever really do. A man, particularly in Java, rarely lives alone (94), as they need someone to prepare their food and to perform household duties. A widowed man will remarry, most likely to a younger woman, while widowed women rarely do so (94). This may be one reason why in this thesis the prevalence of single/widowed women is higher than men. Furthermore, women’s marital status is associated with their socioeconomic position (152). In most
societies, older women account for one of the poorest groups simply because they have experienced the death of a wage-earner husband (3).

The impact of the higher prevalence of abdominal obesity among women can be seen in the higher disability they are faced with. Women have a longer life expectancy (Indonesia, 2015: 71 vs. 67 years, women vs. men) (153), but live with disability partly because of the higher prevalence of non-fatal chronic conditions (154, 155). In this thesis, more women are reported to have more than one chronic NCDs. Therefore, in relation to abdominal obesity, women, especially the poor, were more disabled than men. The extent of the rates of disability differ by gender and socioeconomic status.

**Sex differences in obesity**

The causes of obesity are both social and biological. The biological causes of obesity explain obesity differences between men and women through the role of sex. According to the WHO, ‘sex’ is “the biological and physiological characteristics that define men and women” (140). Women experience more complex hormonal and metabolic fluctuations during their lifetimes (e.g., menarche, pregnancy, and menopause) that could contribute to their higher adiposity (25, 156-158). Research also found differences between the sexes in the actual physiology of eating. Men and women tend to have different food preferences and food consumption patterns that could be influenced by hormones (159, 160). Women are reported to consume healthier foods than men (148), but also consume more sugary foods compared to men (131, 148).

Studies on the long-term impact of early malnutrition also found that mechanisms of energy intake and expenditure, appetite regulation, and patterns of weight gain were different between the two sexes (96, 161-164). These studies showed that women who experienced childhood malnutrition were facing a greater risk of being obese in adulthood than were men (96, 161-164). This might be true in our study setting. In the 1980s, the prevalence of stunting in Asia was estimated to have exceeded 60% (165). It can be argued that fifty years ago (during the 1960s), as a newly-emerged independent country, most of the Indonesian population were living in poverty and struggled from under-nutrition and infectious diseases, that make the population prone to experience obesity in their later life.

**Cultural aspects of obesity**

Cultural factors are known to be associated with eating patterns, physical activity and the population’s perception of obesity (150). In some LMICs, such as South Africa and Indonesia, the population believes that larger body size reflects higher social strata (30-32). In our FGDs, being wealthy was associated with obesity, which further leads
to diabetes. Being wealthy means the variety of food becomes wider, housework can be delegated to a maid, and so there is less laborious work.

Recently, Sohn (2017) conducted a study about obesity and happiness in Indonesia. Sohn found that obese Indonesians were more satisfied and happy with their lives compared to the non-obese, because the obese enjoyed higher SES compared to the non-obese (32). Happiness resembles a good life, and it is appealing (166). Therefore, being obese was seen as admirable not because people want to become obese, but because they relate obesity with being wealthy. Therefore, even though negative attitudes towards ‘the wealthy diabetic’ were observed during FGDs, it can be hypothesised that this action of ‘blaming the victim’ may be a sign of ‘jealousy’ (167).

Communities recognise a disease based upon the degree of its abnormalities, and being seen as abnormal depends on the culture where the disease occurs (168). In our study, diabetes was recognised in the community because of its physical consequences (i.e. rapid weight loss, diabetic wounds, amputations). The community was aware that diabetes is a ‘terrifying disease’, but their ‘unrealistic optimism’ may keep them from taking preventive action.

People might take serious action to prevent the disease if they have good health literacy. People with inadequate health literacy frequently hold poor health beliefs and attitudes, which leads to poor health decisions (169). The actions people take to maintain their health depend on several factors including how they perceive the threat of the disease (170). If people have more accurate knowledge about chronic NCDs, they might be better in identifying their risks, perceiving that they are susceptible to a disease, and have more awareness that they will suffer severe consequences from it. In addition, creating supportive environments and tailoring interventions together with people in the community will improve their health literacy and help the community to have the confidence to act in their own best interests (171).

Measurement of obesity in population-based studies among older people
This study used the waist circumference cut-off based on the WHO cut-off recommendation for Asian population (56, 65). The cut-off is one of the most commonly used cut-offs in multitude research involving Asian ethnicity respondents (56, 65). During the analysis, concern was raised about the large discrepancies of abdominal obesity prevalence in men and in women. Other studies from Indonesia have confirmed a similar result (30, 77, 102).

We ensured the quality of the waist circumference data observed in this study by following the standardised INDEPTH-WHO SAGE study protocol for data collection and
waist measurement. We implemented data quality control procedures, including providing a series of training for field surveyors prior to data collection, conducting spot-checks and re-checks by the field supervisor during the data collection processes. Therefore, we are confident that the prevalence of abdominal obesity reported in our study is valid and free from measurement errors.

**Policy implication**

Socioeconomic inequality exists in our study population, and it is attributable to a higher prevalence of abdominal obesity among the more affluent groups. It is important to note that addressing obesity prevention should not be limited to the richer groups who have higher obesity prevalence. Our study showed a narrower socioeconomic inequality gaps in the burden of abdominal obesity among women, reflecting a higher burden of abdominal obesity among the poor women. This cross-sectional finding is in agreement with many other studies that have reported a shift in the obesity burden towards the poorer groups (76, 95, 102). Therefore, community health promotion activities and campaigns are needed to increase community awareness on the health effects of obesity and promote healthier food choices. Government efforts to provide low-cost healthy meals and fresh and green products are also essential to increase the availability of these healthier choices for low-income older people.

This study also shows that the impact of abdominal obesity on disability and mortality is different across socioeconomic positions. For some Indonesian older adults, especially the poor, health care costs are often unaffordable (90). Problems regarding health care costs were mentioned by the FGD participants, who stated that only the wealthy can afford diabetes medication and care, and that is the reason why the wealthy have the chance to live longer than the poor. Government efforts are needed to help the poorer older people have equal access to health care, as this is very important in reducing health inequality.

Understanding how culture affects the community in perceiving illness is necessary to achieve successful health promotions or disease prevention programmes. Javanese people have a strong belief in maintaining “balance and harmony” in their personal health (172). Utilising the concept of “balance and harmony” in delivering health messages to the Javanese might be one good strategy. For example, addressing the importance of balancing food intake with physical activity by arranging healthy food cooking demonstrations in a community gymnasium (Figure 22). Health promotion activities should involve the community leaders who understand the local culture, so the health message will reach all segments in the community.
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Figure 22. Cooking demonstration and community gymnasium. 

Although the likelihood of chronic NCD increases with age, research shows that the origins of risk factors for chronic NCDs establish themselves at younger ages (173). Furthermore, health behaviours and lifestyle that lead to chronic conditions might be a result of intergenerational transmissions (174). Thus, addressing obesity prevention should be started at a younger age. Obesity prevention programmes at school-level is essential and effective for instilling healthier lifestyles and preventing obesity in adulthood (175).

Strengths and limitations of the study

This thesis has several strengths. First, the quantitative studies were conducted using a large representative sample of older adults aged 50 years and older, in a well-established HDSS site with a more than 90% follow-up rate. Second, this thesis utilises both cross-sectional and longitudinal data. To our knowledge, longitudinal study on the impact of abdominal obesity on health and mortality in Indonesian older subjects is scarce or non-existent. Third, this thesis analyses abdominal obesity measured by waist circumference, which is superior to BMI, particularly among older people and Asian populations (55, 56). Research has shown that waist circumference has a stronger association with type-2 diabetes, CVD, and all-cause mortality than that of BMI (55, 176). Lastly, a combination of quantitative and qualitative approaches in our thesis enables more in-depth understanding on chronic NCDs and obesity as the risk factors.

Several potential limitations should be considered in our thesis. First, there were several slightly different recommendations on waist circumference cut-off values for Asian populations, which might hamper the comparability of our findings with those from other studies. We used the cut-offs of abdominal obesity for Asian population recommended by the WHO and International Diabetes Federation (IDF) (56, 65).
Second, the thesis should also ideally include obesity status at middle age to avoid the selective survival bias and the cohort effects (177). Furthermore, it is also important to include BMI measurement to be able to conduct more analysis and compare the association of BMI and waist circumference to disability and mortality. The facts that our participants’ height and weight data were self-reported with missing rates of more than 23% did not allow us to explore the association or compare the results from both measurements.

Third, the inequality study (sub-study 2) includes a binary outcome for obese and non-obese categories. Therefore the concentration index analyses need to be corrected by following the methods proposed by Wagstaff and the World Bank (117, 119). This correction also applies to the decomposition analysis. The use of other correction methods might result in slightly different estimates.

Fourth, studies assessing the association between obesity and mortality (sub-study 4) require large samples to capture the wide range of adiposity measurements as well as a sufficient follow-up period (136, 178). The 3-years follow-up time in this study was not long enough to capture more events, and it is possible that longer follow-up time may ensure more statistical power to uncover the association between obesity and mortality as well as reveal the socioeconomic and gender differences.

**Implication for future studies**

It is important to understand patterns of morbidity and mortality to allocate resources and address inequalities among Indonesian citizens, as Indonesia has aimed to provide affordable health care for all its citizens. In 2014, the mandatory National Social Health Insurance Scheme, known as the *Jaminan Kesehatan Nasional (JKN)*, was launched. The *JKN* is managed by *Badan Penyelenggara Jaminan Sosial (BPJS)*, and aims to provide universal health coverage for Indonesian citizens, with the government covering a modest premium for the poor (91, 179).

By 2017, *JKN* served 68% of Indonesia’s total population, through their 26,000 health providers and health facilities across its 34 provinces (91, 180). The government plans to achieve universal health coverage in 2019 by serving 95% of the population (179). Although the programme was driven by a political agenda and its continuation might be determined by political concerns in the country (180), a study has already reported a reduction in financial barriers to care among the poor populations in Indonesia (181). Thus, the patterns of SES inequality in disability and mortality that we observed in this thesis might be changed, as now the poor have better access to health care than was the case in 2010.

Future studies should consider longer follow-up periods as obesity effects may show at a slow rate. Having cause-specific death information, smoking status, and
chronic NCDs diagnosis will also be beneficial, and will improve accuracy in predicting death related to abdominal obesity (182). In addition, it is also important to consider the role of gender and socioeconomic status across the life course.
Conclusion

This thesis highlights the importance of socioeconomic positioning in the distribution of abdominal obesity and its impact on disability and mortality among men and women aged 50 years and older in Purworejo District, Central Java, Indonesia. Our result was also strengthened by the community perception on the chronic NCDs and risk factors.

1) The community viewed diabetes as a disease for the wealthy. They have negative perceptions about diabetes and they have unrealistic optimism when viewing their own risk factors.

2) Socioeconomic inequality in abdominal obesity exists and is concentrated more among the richer population. The inequality gap is less prominent among women compared to men, which may reflect a higher burden of abdominal obesity among the poor women.

3) Abdominal obesity is prevalent among the rich, but disability is more prominent among the poor. Women have more disabilities than men. Increases in waist circumference were positively associated with increases in disability.

4) A U-shaped association was observed between waist circumference and all-cause mortality. The poor with low waist circumference showed higher risk of mortality than the rich. Higher waist circumference was advantageous for poor men and women.
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