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The effect of the JOGG program on the prevalence of overweight among youth in the Netherlands

A Generalized Difference-in-Difference Analysis of how the JOGG program impacts the prevalence of overweight among youth in Dutch municipalities

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Keywords: JOGG; Childhood overweight; Community-based intervention; Lifestyle; Evaluation; Generalized Difference-in-difference; Variation in treatment timing; Event study

ABSTRACT

Background The rising prevalence of overweight is a global problem with health consequences and economic consequences. Integrated approaches are promising for reducing overweight, but evaluations are often missing. JOGG is an integrated approach that has been introduced in 147 municipalities in the Netherlands. They aim to reduce overweight among youth. The aims of this thesis are to i) construct one dataset with data about the overweight prevalence among youth from 4 to 19 at the municipality level in the Netherlands, and ii) investigate whether the JOGG intervention reduced the prevalence of overweight among children in JOGG-areas compared to non-JOGG areas.

Method Data of 353 municipalities on the prevalence of overweight and JOGG implementation status were combined into one dataset. To compare whether the prevalence of overweight was different in JOGG municipalities compared to non-JOGG municipalities, a generalized difference-in-difference analysis was performed as the main analysis. Complementary, an event study analysis was performed to explore the dynamic effects of JOGG on the prevalence of overweight over time. Additional analysis were performed for different income groups, to compare whether the effectiveness of JOGG on the prevalence of overweight was different for municipalities with a low SES vs. a middle/high SES.

Results The main results of the generalized difference-in-difference analysis showed a significant increase in the prevalence of overweight after implementation of JOGG. However, the parallel trends assumption was violated, so the results should be interpreted with caution. The results of the event study analysis showed an insignificant increase in prevalence of overweight in JOGG municipalities after 2 to 5 years of implementation. For the whole sample, a significant decrease in prevalence of overweight was found.

Conclusion No effect of the JOGG program on the reduction of overweight was found, and if any, it is positive. These findings question the capacity of JOGG to achieve better weight outcomes in the examined time frame.

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1. INTRODUCTION

1.1 TRENDS AND DEFINITION

The increasing fraction of the overweight population is a health problem that is receiving increasing economic attention (1). Since 1980, obesity prevalence has worldwide continuously increased and has doubled in more than 70 countries (2). The proportion of overweight children is also high, over 340 million children from 5 to 19 years were overweight or obese in 2016 (3). In the Netherlands, in 1990, one in three adults was moderately or seriously overweight. Since then, the number of overweight Dutch people has risen sharply to half of all adults and 13.9% of children from 4 until 17 years in 2019 (4). The prevalence of obesity among children has been lower than adults, but attention is still needed for this problem because the rate of increase in childhood obesity was greater than the rate of increase in adult obesity in many countries (2).

Overweight and obesity are defined as “abnormal or excessive fat accumulation that presents a risk to health” (3). Overweight and obesity in adults is classified by the body mass index (BMI). This is an index of weight-for-height that is defined as a person’s weight in kilograms divided by the square of his height in meters (kg/m^2) (5,6). For adults, a BMI $\geq$ 25 is defined as overweight, and a BMI $\geq$ 30 is defined as obesity. For children, their body composition varies as they age. Rather than the BMI categories used for adults, an age- and sex-specific percentile determines the health status. In 2000, Cole et al. established new internationally acceptable cut-off values for child overweight and obesity, based on pooled international data for body mass index. (7). These new cut-off values should encourage direct comparison of trends in child obesity worldwide. The cut-off values for overweight vary by sex and age between 2 and 18 years, and range from 17.2 to 24.7 kg/m^2 (see appendices A) (7).

1.2 COMORBIDITY

A healthy weight is important. Globally, overweight and obesity are in the fifth place of risks for global deaths (3). Overweight or obesity in children can lead to various health problems in both early and later life. However, somatic comorbidity significantly increases with severity of obesity. Several studies show that high BMI as a risk factor for several adverse consequences for physical and mental health, in both the short term and long term (8). As a result of this comorbidity, a high BMI was linked to 4.0 million deaths worldwide. 60% of these deaths occurred in persons who were not obese (2). In addition, being overweight is related to a lower quality of life (9) and to decrease of life expectancy (10).

SHORT TERM CONSEQUENCES DURING CHILDHOOD

The increasing prevalence of overweight and obesity are big public health concerns. Childhood obesity has short-term adverse effects on both psychological and physical health in childhood (8). Compared to non-obese peers, obese children are more likely to experience psychological problems (8). Girls are at greater risk for psychological problems than boys and this risk increases with age (8). Research where psychological and social characteristics of obese children were examined, showed that obese participants were less liked and rejected more often by peers and reported more depression and a lower self-concept compared to non-obese children (11). In addition to possible psychological consequences, the lower self-esteem also entails other possible health risks, related to high levels of smoking among obese females who reported decreased levels of self-esteem, compared to females who did not report this (12). Weight gain and psychological problems might be two-way related. Weight gain and obesity may lead to psychosocial problems and psychological distress might promote weight gain.

Childhood overweight has other physical consequences for health. First, childhood obesity is related to asthma. It was found that the risk of developing asthma symptoms is increased by becoming obese (13). Also, it was found that overweight in children is associated with more than twofold risk of developing type 1 diabetes mellitus and risk of developing type 2 diabetes mellitus (14,15). The preliminary stage of diabetes mellitus is frequently seen as obesity and age increase (14). Further, it is suggested that obesity may be associated with low-grade systemic inflammation. For example, it was found that being overweight was significantly associated with increased serum C reactive protein concentration, an early marker of inflammation or infection (16,17). Also, obesity is associated with children having obstructive sleep apnea, a higher prevalence of high blood cholesterol, and more mobility limitations compared to adolescents with a healthy weight (18,19). Last, there is also increasing amount of evidence that childhood obesity is associated with increased cancer risk in adulthood (20).

Long term consequences during adulthood

Overweight and obesity are not only associated with the short-term consequences mentioned before, but also have long-term consequences during adulthood. Children who are overweight or obese are at high risk of remaining obese into adulthood and to develop noncommunicable diseases associated with being overweighted in adulthood (21). The most common comorbidities that occur in adulthood will be described.

The most common comorbidities of overweight and obesity are cardiovascular diseases. More than two out of three the deaths related to high BMI were due to cardiovascular disease (2,22). Obesity might lead to hypertension by increasing renal sodium reabsorption, impairing pressure natriuresis, and volume expansion (23). The risk of hypertension increases increasively with higher levels of BMI (24,25). It was found that an increase in each unit of BMI, the risk of hypertension increases with 12% (26). An increase in body fat is not only associated with an increased risk of cardiovascular diseases, but also other metabolic diseases such as type 2 diabetes mellitus and dyslipidemia (25). In several studies it was observed that diabetes type 2 and glucose intolerance are associated with overweight and obesity (25,26). This association increases with the degree of BMI. The prevalence of type 2 diabetes in overweight and obesity in the APNA study among 40,000 adults was 11.5% and 25.2% respectively (25). Type 2 diabetes itself is associated with chronic complications such as cardiovascular diseases, eye defects and kidney diseases (27). Finally, carrying excess weight can lead to musculoskeletal disorders. For example, it was found that overweight persons are at high risk of osteoarthritis in the knee (28).

1.3 Health economic approach

Overweight and obesity do not only have health consequences for individuals but have also social and economic consequences. The economic burden of overweight and obesity can be classified into two components: i) direct (medical) costs and ii) costs related to indirect morbidity and mortality outcomes (29). The association between obesity and direct and indirect costs has been found may times (30). Overweight and obesity have a substantial economic impact in different European countries (31). The total costs associated to obesity are ranging from 0.09% to 0.61% of national gross domestic income (31).

DIRECT COSTS

Direct medical outcomes are the measures of prevention, diagnosis, and treatment services (29). Many studies into the impact of overweight on health care costs have been carried out in the US. This is not surprising given the scale of this problem in the US. One of these studies assessed healthcare claims and costs among First Chicago Bank employees (32). The results reported that employees with at-risk BMIs (defined as >27.8 kg/m2 for men and >27.3 kg/m2 for women) had overall health care costs of $8,799 over three years, in contrast to average health care costs of $5,245 for employees without an at-risk BMI (32). Another study found that each increase in point of BMI was associated with a 1.9% increase in medical charges (33). Also in Europe, overweight and obesity are responsible for a substantial economic burden (31). A review described studies about Europe and reported that a 1% to 4% of total healthcare expenditure can attributed to obesity (30). In Germany, obesity caused 2.1% of overall health expenditures. 43% of direct costs resulted from endocrinological diseases like diabetes and obesity itself, followed by cardiovascular diseases (38%), neoplasms (14%) and digestive diseases (6%) (34). A study has calculated that the direct annual healthcare costs in the Netherlands associated with obesity *and* overweight (BMI>25 kg/m2), should amount to approximately 4% of total healthcare costs (30).

INDIRECT COSTS

Overweight and obesity are also related to indirect costs resulting from morbidity and mortality. Indirect costs are defined as “losses from reduced work productivity due to short-term and long-term incapacity for work and absenteeism” (29,35,36). This risk is even higher for obese people (36). In a review of four studies that presented estimates for indirect costs of overweight and obesity, it was found that the indirect costs account for between 54% and 59% of the estimated total costs (30).

Indirect costs due to overweight and obesity can be divided into categories such as presenteeism, absenteeism, disability, premature mortality, and worker compensation. Presenteeism refers to a situation in which the employee remains in the workforce, but their productivity is adversely affected by their health condition, for example because of their mobility being reduced. (30). A study calculated that obese workers with a BMI of 35 or higher experienced the greatest health-related work limitations. Health-related productivity loss equates to an additional $506 annually per worker. (37). The issue of absenteeism is important to consider when calculating the costs of overweight and obesity. This is the most common measure of indirect costs. In the case of absenteeism, obesity is associated with an increased risk of temporary work loss such as sick leave (38). For example, the results of a review showed that the annual excess costs of short-term sick leave from work were estimated to be between $54 and $161 for overweight employees, compared to employees with normal weight (39,40). For obesity-related costs, the excess costs were between $89 and $1586 (39,41).

Costs related to childhood overweight and obesity

Although most increases in healthcare costs or expenditures will be expressed in the long-term in adulthood, childhood obesity may also have economic consequences. Besides healthcare costs that might be experienced during adulthood, childhood obesity is associated with substantial indirect costs due to increased risk of children's psychosocial problems (42). F few studies provide evidence of additional life-time costs due to childhood obesity (38). For example, a Markov study that estimated the total lifetime costs of childhood obesity in Germany found that childhood obesity is the top contributor to the overall cost burden across all decades of life. For adults with a history of childhood obesity, the overall costs are 8 times higher for adults between 41 and 51 compared to adults without a history of childhood obesity (43). An example of indirect economic consequences on individual level: a study found that British girls born in 1958 who had a BMI above the 90th centile when they studied had significantly lower income than girls with a BMI below the 90th centile. On average, the income differed 7% at age 23. These results were controlled for social class and intelligence quotient (44).

A relevant question to ask is what the economic benefits of prevention overweight and obesity during childhood are. In Germany, it was estimated that reduction in lifetime excess cost would be €4.1 million for the current prevalent population if the prevalence of childhood obesity were reduced by 1% (45). These costs could be further reduced by €27 million if the prevalence of childhood overweight and obesity could be reduced by 14% (45).

1.4 Relevance and aim of the study

To recapitulate, for several reasons it is crucial to tackle childhood overweight and obesity and to normalize body weight. The majority of children with overweight and obesity remained in the same BMI category during their adult life (43). Obesity during adulthood is significantly associated with increased risk for health problems like cardiovascular diseases and metabolic diseases such as type 2 diabetes, increased risk for malignancies in adulthood. Increasing duration of obesity is significantly associated with an increased risk of mortality, so if overweight is present in childhood, the health consequences at later life will be even larger (46,47). On short term, overweight and obesity can lead to psychological problems and physical problems like asthma and sleep apnea during childhood. The economic burden of obesity is also substantial. Health care expenditures and indirect costs related to overweight and obesity were reported to increase during childhood, but mainly during adulthood, resulting in significant indirect lifetime costs (45). Findings suggest that preventing obesity may lower the overall burden of disease and might decrease total healthcare expenditures.

Overweight and obesity during childhood are not only a medical concern, but also an economic problem that needs to be tackled. Because of the large impact of obesity on population health across the world, an effective strategy to prevent and manage the epidemic is urgently needed (48). Fortunately, there is an increase in well-conducted interventions that want to reduce overweight and obesity among youth. However, (health economic) evaluations of these kind of interventions are often missing (1) and the effects of the approaches are often small (49).

In the Netherlands, the JOGG (*Jongeren Op Gezond Gewicht*, Young People at a Healthy Weight) program was introduced in 183 of the 352 municipalities. The JOGG program encourages all young people in a city, town, or neighborhood to make healthy choices and want to make exercise easy and attractive for young people (0-19 years) (50). This program will be further described in chapter 2. The approach bu JOGG is promising, nonetheless it is important to explore if the JOGG program reduces overweight.

Different studies evaluated the effectiveness of the JOGG program or similar programs (51–56). Some evaluations found that the prevalence overweigh was reduced (52,54,56) but only small effects were found. The evaluations had some (methodological) limitations. Most studies included only a small age group or sample. For example, the effect of the program was evaluated only for the age group from 5 to 6 years, while the program aims to reduce overweight among young people from 0-19 years old (51–55). Some studies did not use control group (51,52) or included only two control municipalities (53). A Dutch study evaluating JOGG at the national level, found that JOGG is effective, but their dataset was based on few observations (56).

The aims of this study are to i) construct one dataset with data about the overweight prevalence among youth from 4 to 19 at municipality level in the Netherlands, to evaluate the impact of the JOGG intervention for the entire country at the municipality level, and ii) investigate whether the JOGG intervention reduced the prevalence of overweight among children in JOGG-areas compared to non-JOGG areas. The following research question will be answered in this thesis:

> *Did the JOGG program reduce the prevalence of overweight among Dutch youth living in JOGG municipalities compared to youth living in non-JOGG municipalities?*

The thesis is organized as follows. Chapter two will provide more information about the characteristics of an effective intervention program, according to the literature. Also, the procedures of JOGG will be described. To point out the relevance of this thesis, strengths and limitations of former evaluations of similar interventions based on the same approach as JOGG will be discussed. In chapter three, it is described how the data used in this thesis was gathered. Further, the variables are defined, the summary statistics are shown, and a description of how the empirical analysis were performed is given. Chapter four contains the results of the generalized difference-in-difference analysis and event study analysis. Chapter five will discuss the findings, strengths and limitations of this thesis, provides recommendations for further research. Finally, the conclusion of this thesis is given.

2. THEORETICAL FRAMEWORK

This chapter presents important strands of literature related to the topic of this thesis. First, the problem of overweight will be analyzed, so it is clear what factors should be considered when developing an intervention to reduce overweight. Second, more information will be provided about what is already known about effective ways to prevent and reduce (childhood) overweight and obesity. Then this chapter will provide more in-depth information about JOGG. Last, previous evaluations on the impact of the JOGG program and comparable programs on overweight will be presented, which are important to have in mind in discussing the findings of the thesis.

2.1 PROBLEM ANALYSIS

The increase in body weight at an individual level as well as development of obesity at a population-based level is attributable to a bunch of different factors. Although other factors are involved in developing overweight, it is widely accepted that the fundamental cause of overweight and obesity is a chronic positive energy balance (3). Easy said, a positive energy balance is caused by a food intake that is too high for the number of calories the body needs to operate, the physical activity is too low for the energy intake, or both.

The obesity epidemic is global in nature (57). Technological, economic, and social changes have created an obesogenic environment that contributes to weight gain. Several studies are suggesting that the food intake or high energy intake is globally responsible for a higher BMI (22,58,59). The main drivers that contribute to weight gain are mainly the result of changes in global food system: these changes have altered the opportunity cost for behaviors related to energy intake and energy expenditure (60). Due to technological innovations, it is possible mass prepare food and consume it with lower time costs of preparation and cleaning. Also more energy-dense food is produced (61). Additionally, the effective marketing techniques are associated with increasing obesity rates (62). Multiple studies found that TV advertising of foods and drinks contributes to the prevalence of childhood obesity (62).

The other side of the positive energy balance is a decrease in physical activity. Avoiding “time-wasting” physical activities such as working to school, the changing nature of many types of work, more access to transportation and increased urbanization contributed to decreased physical activity (3).

At a local level, individuals respond to environmental factors like sociocultural and economic factors and the physical environment. At a national and local level, substantial differences in environments (national wealth, government policy, cultural norms) produce variation in obesity prevalence across populations (63), where wealth is a precondition for a population to develop obesity (57). The relation between GDP and mean BMI is positive and linear up to a GDP of about US$5000 per person per year, at a higher GDP the relation is almost flat.

Another determinant that plays a major role in developing eating behavior in children, is the family surroundings. It was found that children adapt their caregiver's eating habitats (64). Within populations, individual factors explain variation in body size between individuals, including genetic makeup (65). Other individual factors that may contribute to the growing prevalence of overweight include genetic mechanisms, biological bases for food preferences and biological mechanisms that regulate motivation for physical activity (63).

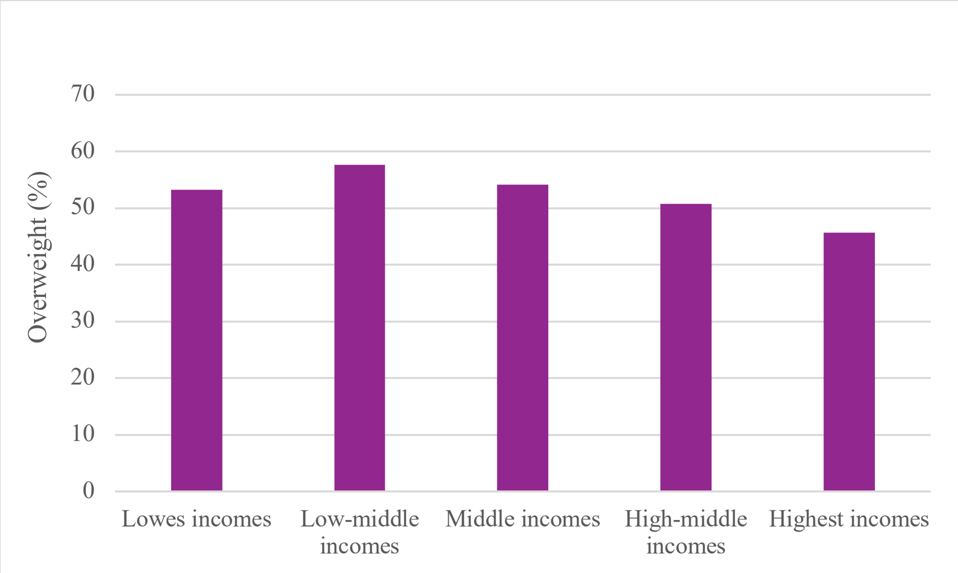
ROLE OF SOCIOECONOMIC STATUS

In high-income countries like the Netherlands, obesity affects both sexes and all ages, but is disproportionately greater in disadvantaged groups (57). A low SES level of the living area to be related to a higher prevalence of obesity (66). Research found that children with low SES are twice more likely experience obesity than children with a high SES (67). This can be explained by the many (health) risk factors for childhood obesity that are related to SES, for example neighborhood safety, lower educational attainment, smoking, drinking soda, and watching television (65).

The socioeconomic status (SES) is "the standing or class of an individual or group, often measured as a combination of income, education and occupation" (68). Looked at income separately, the percentage of overweight decreases as the income class increases, this applies to both men and women from the low middle income class to the highest income class (4). Figure 1 shows the percentage of overweight among adults who are 25 years and older by income level in 2016 in the Netherlands (4). People with low-middle incomes are more likely to be overweight in than the people with the highest incomes in all age categories for both men and women (4).

Figure 1

Overweight by income level 2016



The previously mentioned findings with regard to SES are important to take into account when evaluating the effect of the JOGG intervention, because the effect might be different for areas with low SES compared to high SES.

Characteristics of a good intervention

Prevention of overweight and obesity can lead to health improvements and reduction of various direct and indirect health-related costs. The changes needed to reverse increasing prevalence seem to require interventions that impact several levels like individual behavior, interventions at local level or sector changes within sectors. There is no clear consensus reached on effective policy or programmatic strategies (63). However, quantitative modelling has helped to develop approaches that are science-based (57,69).

Given the economic burden on the society of childhood obesity, it seems to be the most cost-effective to target at reducing the prevalence of obesity during the early years of life, since this can reduce both healthcare and non-healthcare costs over the lifetime (45). New preventive programs should actively encourage people to change their lifestyle in a healthy way (70). Preventive programs against overweight and obesity need to focus: 1) on approaches that consists of multiple components, to address eating behaviors and energy balance, physical activity, and inactivity; 2) on targeting on multiple levels: individual children, families, primary care providers, and community youth-serving organizations; 3) on multiple settings: schools, community centers, and homes (49). These kinds of interventions are called integrated approaches (63).

2.2 JOGG

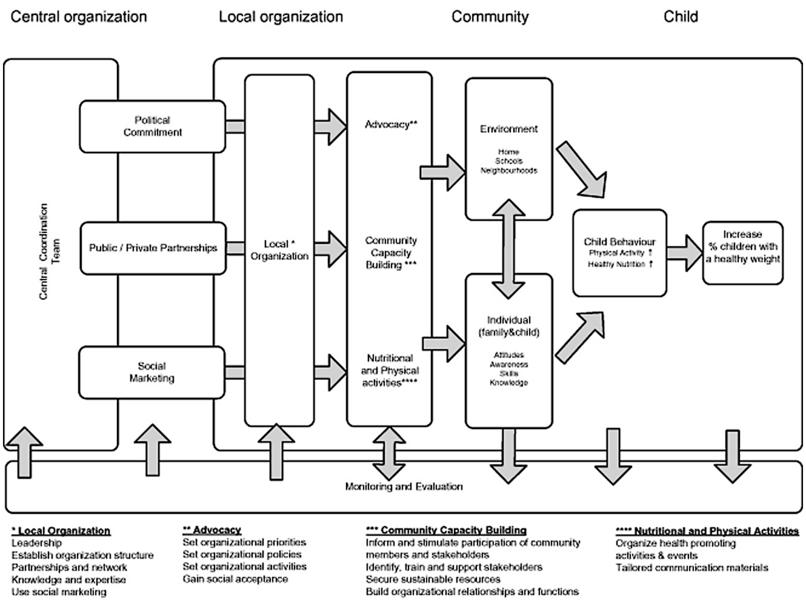
One of the existing integrated approaches is the JOGG program in the Netherlands. JOGG has been inspired and influenced by the methodology of the French project EPODE (71). The EPODE ('Ensemble Prévenons l'ObésitéDes Enfants', *Together Let's Prevent Childhood Obesity*) approach aimed at reducing childhood obesity through a societal process in which local environments, childhood settings and family norms are directed in a way that they encourage adoption of healthy lifestyles in children (72). EPODE focusses on step-by-step learning, and an experience of healthy lifestyle habits, tailored to the needs of all socioeconomic groups. The EPODE program was piloted in 2004 and has since been introduced in over 20 countries. One of these countries is the Netherlands, which introduced JOGG in 2010 (73).

EPODE APPROACH

The EPODE approach advocates the installment of stakeholders at the central level and at the local level (71). First, the EPODE program must be supported by central public authorities and scientific organizations. EPODE is in each country or state coordinated by the Central Coordination Team (CCT) to ensure overall management of the program. The CCT is also in charge for the program's content at central level and coordination of the evaluation and monitoring scheme. At a local level, the local project manager's role is to activate stakeholders to implement EPODE components. The key settings to implement activities with children and families are schools, pre-schools, extra-curricular organizations (71). Practical examples of components of EPODE include the optimization of the school catering service or changes to physical environments, such as rearrangement of school playgrounds, the installation of sport courts in neighborhoods, the development of gym facilities, and improvements to the footpaths in the town (71). Local project managers are free to implement interventions they deem suitable to implement in their community, based on the points of improvement in the community. Components can be implemented for a specific period or continuously and the components that are applied can differ by country, municipality or even neighborhood. Figure 2 describes the methodology in the form of a logic model by Van Koperen et al. (74).

Figure 2

EPODE methodology

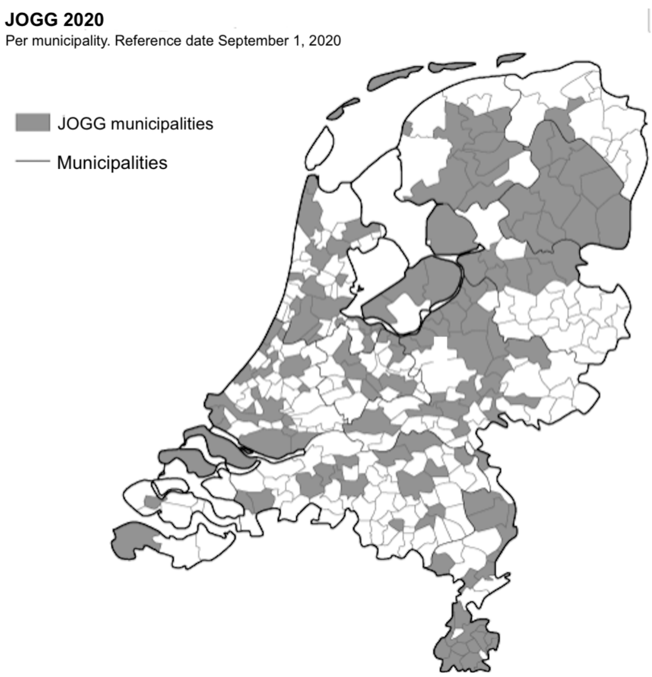


JOGG IN THE NETHERLANDS

The Dutch adaptation of EPODE is JOGG. Currently, more than half of the Dutch municipalities are part of the JOGG movement (n=183). Figure 3 shows a visualization of the municipalities that implemented JOGG in 2020.

Figure 3

Visualization of JOGG per municipality in 2020



Like EPODE, JOGG aims to reduce the prevalence of overweight (i.e., not just obesity) among youth from 0 to 19 (73). To live up their ambition to make the living environment in all municipalities in the Netherlands healthier, an integrated approach at policy level, executive level and at neighborhood level is used. Instead of four, the JOGG approach consists of five pillars: political commitment, co-operation between the public and private sectors, social marketing, scientific support, and evaluation, and linking prevention and healthcare (75). The fifth pillar "linking prevention and healthcare" is tailored to the Dutch procedures and has been added in the Netherlands (75). In Dutch towns, it is a procedure that care professionals identify overweight at an early stage, for example by measuring BMI at schools. By linking preventive care with healthcare structures, JOGG aims that young people will receive the support they need.

Figure 4

JOGG approach model

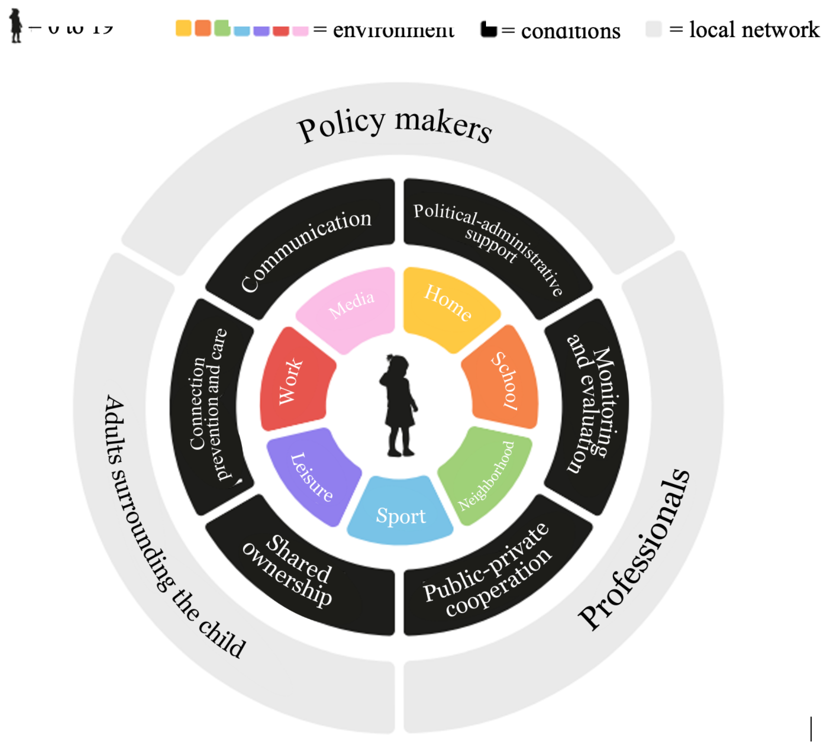


Figure 4 shows the JOGG approach model (76). The local JOGG network is managed by the JOGG team consisting of a JOGG director and the policy officer within that municipality (73). This team creates a working network from the entire community: professionals from childcare, education, sports, welfare, care, and business, often supported by a regional coordinator (73). Municipalities can choose individually to join

JOGG and commit to for at least 3 years. Previously, municipalities were asked to pay a small contribution. As of January 1, 2021, the annual contribution from municipalities has been abolished and municipalities can join for free (77). JOGG is public funded by the Ministry of Health, Wellbeing and Sports (*Ministerie van Volksgezondheid Welzijn en Sport*, VWS) and from various partners who are affiliated with JOGG (73). In 2018, the total budget to spend on the JOGG program was 6 million euros (73).

2.3 Former evaluations

More than ever, obesity and related non-communicable diseases are being taken seriously by many governments. The implementation of multicomponent programs like EPODE and JOGG that include several obesity-related targets, is in theory a promising intervention in treating overweight and obesity. To evaluate the effectiveness in practice, the outcomes of evaluations of several interventions from across the world will be described.

EPODE evaluations

Many practice descriptions were found about the implementation of EPODE (73). However, only a few studies described the effectiveness of the EPODE program. One study analyzed the effectiveness of the VIASANO program in Belgium (54). They compared changes in the prevalence of overweight and obesity over a 3-year period (2007-2010) in children aged 3-4 and 5-6 years. The results showed that the prevalence of overweight decreased 2.1% and overweight and obesity decreased 2.4% (p=.06) in pilot towns compared to general population (54). In contrast, an evaluation of OPAL - the Australian adaptation of EPODE- did not show a significant impact on the proportion of 9 to 11-year-olds in the healthy weight range, nor children's BMI z-score for the intervention communities and the comparison communities after 2-3 years of implementation (51). One of the Spanish EPODE adaptations, the *THAO Salud Infantil* Program, was evaluated in 2020 (52). Villanueva de la Cañada (Madrid, Spain) was selected as pilot city and was therefore used for the evaluation. Results showed a downward trend in overweight and obesity prevalence during the 2010-2019 timeframe. The study confirmed effectiveness of this intervention at the local (municipality) level, in terms of overweight/obesity prevention among 3- to 12-year-old children. However, the actual effectiveness of the program is hard to conclude because no control group was used in this evaluation and the differences in the anthropometric variables were only observed in the intervention group, consisting of one municipality (52). Relevant to mention, this evaluation of the Spanish adaptation also included analysis of the influence of the socioeconomic status on overweight and the effectiveness of the program. Results showed that children from families with lower incomes are in greater risk of suffering from overweight and obesity and showed lower effectiveness of the program (52). An evaluation of another Spanish adaptation of EPODE (TCHP) found that the program did not improve weight development, diet quality, and physical activity in the in Spanish children aged 8 to 10 years after follow-up of 15 months (53). For their evaluation, only two intervention cities were compared to two control cities were used. All these evaluations only analyzed the effect of the programs in small age groups (3-4 years, 3-12 years, 5-6 years, 9-11 years, 8-10 years), and not on the effect on young people as aimed by EPODE.

JOGG EVALUATIONS

Different evaluations on the JOGG process were found (50,73,78). Since 2015, the Mulier Institute evaluates the JOGG program on a yearly base with the 'Monitor Young People on a Healthy Weight'(78). In 2019, the Mulier Institute mapped out the most important developments, the growth of JOGG and the approach within the JOGG municipalities in the period from 2015 to 2019 (78). These evaluations and other JOGG's own evaluations do not focus on the results of the program, but on process (i.e., which activities have been deployed by JOGG, how far are JOGG municipalities processed with the implementation). Also, these evaluations do not indicate whether there are changes in healthy behavior or weight within the JOGG municipalities compared to non-JOGG municipalities (56).

Since the implementation of JOGG in the Netherlands in 2010, to my knowledge, only two studies evaluated anthropometric outcomes between JOGG and non-JOGG areas (55,56). These studies were independently developed around the same time of writing this thesis. The first paper was written by Kobes et al. from the University of Groningen (55). This paper explored how JOGG might reduce overweight prevalence among Dutch children. Secondary anthropometric and personal data of from 209,571 Dutch children from 9-11 years was available from Dutch Center for Youth Health (NCJ). The authors concluded that JOGG appeared to be successful in targeting areas where overweight was most prevalent. Low SES areas that had implemented JOGG for a longer period, i.e., six years, appeared to be successful in decreasing overweight prevalence. Prevalence decreased from 25.17% to 16.08% in JOGG-areas, and from 32.31% to 18.43% in long-term JOGG areas, in 2013 to 2018 respectively. In low SES areas, the results showed a decrease in overweight prevalence in long-term JOGG areas of 32.3% in 2013 to 24.3% in 2018 (55). What the authors did different, compared to this thesis, is that they only assessed one age group, namely year seven of primary school. Since JOGG aims to reduce overweight among all young people, in thesis the age group from 4 to 19 will be included to study the effectiveness of the JOGG program. Another limitation of the evaluation by Kobes et al. is the empirical method (55). Z-tests were used to explore whether there were differences in overweight prevalence between JOGG and non-JOGG areas. This statistical method has restrictions. This test only compares the mean prevalence of overweight in JOGG areas compared to non-JOGG areas. It does not account for initial differences between the municipalities and the time trends. This also does not account for other factors that influence overweight before and after the implementation. The second evaluation was done by the National Institute for Health and Environment (*Rijksinstituut voor Volksgezondheid en Milieu, RIVM)* (56). RIVM has investigated the influence of the JOGG approach on overweight and exercise behavior in children and young people. Data from the Health Survey from 2006 to 2018 was used to analyze changes in overweight and exercise behavior in JOGG and non-JOGG neighborhoods (56). Using the residential addresses of children who have completed the Health Survey and the neighborhood codes of JOGG neighborhoods, they were able to determine whether the child lived in an JOGG neighborhood or not. The analysis showed that for children aged 2-19 years in JOGG neighborhoods, the percentage of overweight children has decreased in all four years after the introduction of the JOGG approach compared to children in the same neighborhoods a year before the introduction of JOGG. A limitation of this study is the limited dataset, because the Health Survey was used as data source. Every year, only 15 thousand people are approached to fill in the survey, with a response rate of around 60-65 percent (79). This ensures that there are few or no respondents per neighborhood available. In this thesis, the data is based on a large sample because the prevalence of overweight in the municipalities are based on measurements of the Municipal Health Service regions. This data includes measures by a school nurse and questionnaires. The method of data collection will be further described in chapter 3.

To summarize, according to the literature, the JOGG method satisfies the characteristics of a well-conducted intervention. Namely, JOGG uses the living environment around the child to encourage healthy behavior. As found in the problem analysis section, the environment plays an important role in the development of overweight. JOGG uses an integrated approach at policy level, executive level and at neighborhood level and, on paper, meets the criteria for integrated approaches (49,63). However, the effects of other EPODE adaptations on the overweight prevalence among youth are debatable and the intervention effects of integrated approaches found in literature are often small (51–56). Further, it was found that the children growing up in families with low SES are more likely to have overweight. Also, SES seems to have effect on the effectiveness the interventions, but the direction is unclear (52,55). Also, the program seems to be more successful in areas that had the program implemented for a longer time (>6 years) (55).

Insights derived from the information mentioned above, lead to the following extra research questions: i) what is the difference in effectivity of the JOGG program on prevalence of overweight among municipalities with relatively lower SES compared to municipalities with higher SES, and ii) what is the difference in the effectivity of JOGG in municipalities that implemented the program for a longer time?

3. DATA & EMPIRICAL STRATEGY

In this chapter, it is described how I gathered the data used in this thesis, how the variables are defined, what empirical strategy was be used and how the assumptions associated with these methods will be tested.

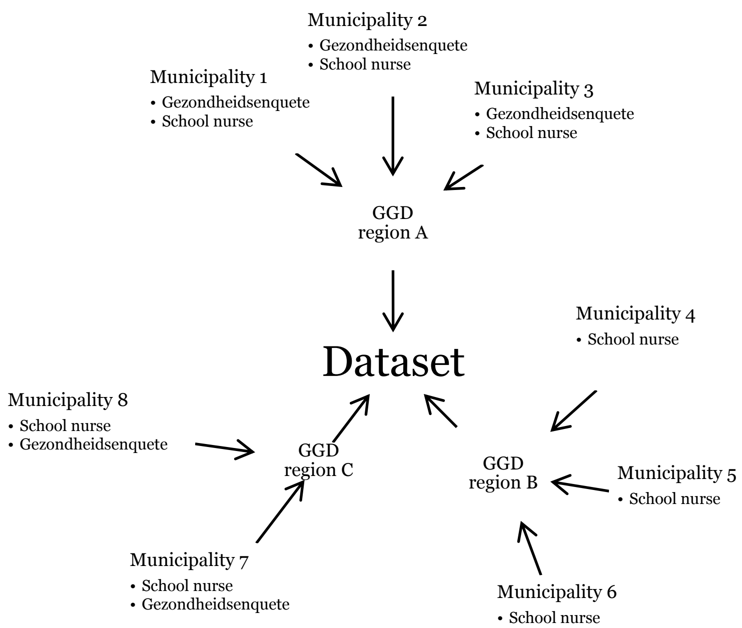
3.1 DATA

DATA COLLECTION

To investigate the effect of the JOGG intervention on the prevalence of overweight among children in municipalities in the Netherlands, panel data, reported on municipal level with annual frequency was obtained. First, data about overweight was obtained from the websites of the Municipal Health Service regions (*Gemeentelijke Gezondheidsdienst*, GGD). The GGDs protect, monitor, and promote the health of the inhabitants of the Netherlands (80). In total, 25 GGD regions are present in the Netherlands that provide and obtain information about the health status of the residents in the municipalities in their GGD region. There are two common sources how GGD regions collected data about the fraction overweight among youth in the municipalities, graphically shown in figure 4.

Figure 4

Visual representation of data collection



Note. data was retrieved from the *gezondheidsenquêtes* and measured by school nurses. GGD regions report the information of overweight prevalence in the municipalities on their website. Some regions shared information about all age groups for all years from 2012 to 2020 but might not have done so for the entire period (for example, only results from the gezondheidsenquête in 2013, 2015 and 2018).

1) Youth Health Monitor (81)

The Youth Health Monitor (*Gezondheidsmonitor Jeugd*) is a digital questionnaire that is administered every 4 years at school in 2nd and 4th grades of regular and special secondary education. In 2015 and 2019 the Youth Health Monitor was carried out by the GGDs and RIVM. In 2015, nearly 97,000 students and 377 schools participated in this monitor. In 2019, this was 171,192 students and 707 schools. The anonymous digital questionnaire was administered at school in second and fourth grades of secondary education. All GGDs carry out this large-scale questionnaire study into the health, well-being, and lifestyle of secondary school students in grades 2 and 4 in the same way. This makes it possible to compare the results at national, regional, and municipal level.

2) Measure by school nurse

As soon as a Dutch child starts school, they are invited by the GGD to participate in a periodical school-based health checkup (82). Participation is not mandatory, but encouraged. The GGDs sends a nurse to the schools that monitors the development of the child (82). During the checkups, anthropometric measures of weight and height were collected. These checkups often take place in second year of primary school (usually 5 to 6 years old), seventh year of primary school (usually 10 to 11 year), second class of secondary school (usually 13 to 14 years old) or fourth class of secondary school (usually 16 to 17 years old). The data was stored at GGDs and information about percentage overweight at municipality-level per year in the measured age group, can be found at the GGD website of the specific region. Not all GGD regions provided information about all age groups, all years, or provided information at all. The assumption is made that the school nurses and GGD regions measured the fraction of children with overweight within the age category correctly, and they did proper data reporting.

Data collection of overweight prevalence was limited to 2012 to 2020, because most municipalities did not publish results before 2012 or after 2020 online. Also, data collection was limited to data from the age of 4 years old, because there are still few proven effective interventions specifically aimed at promoting healthy weight for target group -9 months to 4 years (83). Including this age group could possibly bias the results of the effectiveness of JOGG.

WEIGHTED AVERAGE

There were four common age groups for which information is reported: second (5-6 years) and seventh class (10-11 years) of primary school, and second (13-14 years) and fourth class (15-16 years) of secondary school. To calculate the average, a weighted average based on total number of children in these age groups in the municipality was calculated. There is no data available about the total number of children per year per age group in the municipalities. Therefore, the data from CBS about the number of living children born per municipality per year was used. To illustrate, the overweight prevalence in 2013 for 5-year-old is 12% and for 10-year-old is 8.9%. To estimate the number of children who were five or ten in 2013 in municipality A, I took the number of children born alive in municipality A in 2008, 2003 respectively. An assumption made is that all children remain living in the municipality. The weighted average of the values x_1=12% and x_2=8.9% with weights g_1=2000 and g_2=3100 can be calculated as follows: $\bar{x} = \frac{12*2000+8.9*3100}{2000+3100} = 10.12\%$

AGE-STANDARDIZATION

JOGG claims to reduce overweight (i.e., not only obesity) among youth until 19 years old. The percentage overweight in the Netherlands is not evenly distributed among age groups. The prevalence of overweight is less among younger children compared to higher age groups. Also, the GGDs provided data about limited age groups, instead of the total age group from 4 to 19. To correct for skewed distribution of overweight among age groups and to make data comparable between municipalities (i.e., same age groups), a factor to age-standardize was applied. Individual age groups were multiplied by a factor.

To calculate the percentage overweight in different age groups in the Netherlands, the Dutch *Gezondheidsenquêtes* from *Central Bureau for Statistics* (Centraal Bureau voor de Statistiek, CBS) from 2012 to 2018 were used. (84–90). The *gezondheidsenquête* contains information about the height and weight from the Dutch populations for all ages. The results of these questionnaires were combined into one dataset. Using the weighted variables for age of respondent at the date of interview (*age),* gender (*gender)*, the height of the respondent at the date of the interview (*height*) and the weight of the respondent at the date of the interview (weight). To determine whether a respondent had overweight, the international gender and age-dependent BMI cut-off values established by Cole et al. were used (7). For every age group from 2 until 19, a dummy variable was made for overweight (1=yes or 0=no). The dummy variable showed the percentage of overweighted children per separate age group. To calculate the average, the weighted average for the total number of children per age sex and group in the Netherlands was calculated.

To illustrate, if a municipality reports that the percentage overweight among children from 5 and 6 years old is 14%, it is likely that among youth from 4 to 19 in that municipality, the percentage overweight is higher. The percentage overweight calculated with the Dutch Gezondheidsenquête for all children in the Netherlands from 4 until 19 years is 17.9%, and the percentage overweight for age group 5-6 years old is 12.5%. This is a factor of 1.4 higher. The data on municipality-level for the age group 5 to 6 was multiplied by this factor, to estimate the percentage overweight among 4 to 19 years in the municipality.

DATASET

The data was combined in STATA to obtain a complete panel data set, and each municipality got an individual code from 1 to 353 as the identifier. The total number of observations was 2,471, which corresponds to 353 municipalities in the Netherlands from 2013 to 2019. The number of municipalities was based on the municipal grouping in the Netherlands on January 1, 2021 (91). GGD region Zuid-Limburg (N=16), Gelderland-Midden (N=15), and GGD Gooi en Vechtstreek (N=7) missed information on municipality level about the prevalence of overweight in their municipalities. For recently merged municipalities, the data on overweight prevalence was also coded as missing. For these merged municipalities there was no data available about the children born alive in the municipality, and thus not possible to calculate the weighted average, or it was not clear how the GGD calculated the overweight prevalence for these merged municipalities based on the data of the former municipalities.

Most municipalities reported data on the overweight prevalence in 2016 (n=266). In 2012, from only 6 municipalities data on the overweight prevalence was available and from 37 municipalities in 2020. Due to the limited data in 2012 and disrupted collection of the data collection by school nurses in 2020 due to COVID-19 (4), only data about overweight from 2013 to 2019 will be used in the analysis. In the remaining dataset, the total number of observations was 2,471, which corresponds to 353 municipalities in the Netherlands from 2013 to 2017.

3.2 VARIABLES

PREVALENCE OF OVERWEIGHT

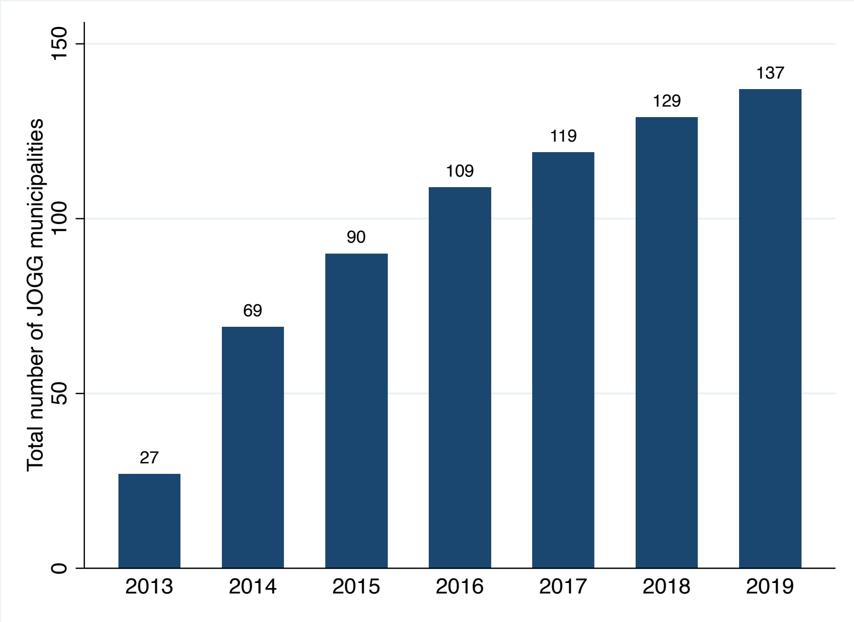
The variable *overweight* was used as the dependent variable. As described in the section *data collection*, data was derived from websites of the GGD regions, who reported the prevalence overweight of their corresponding municipalities. The prevalence includes the prevalence of overweight *and* obesity, according to the cut-off values for overweight among children (7). The prevalence was reported as a fraction between 0 and 1, where 0.1 comes down to a prevalence of overweight of 10%. The mean prevalence of overweight among the whole sample is 0.16. *Overweight* has in total 1,446 observations. The lowest prevalence of 0.03 was measured in 2015 in a non-JOGG municipality. The highest prevalence of 0.4 was measured in 2016 in a non-JOGG municipality.

JOGG STATUS AND YEAR OF IMPLEMENTATION

The main variable to describe the variance in prevalence of overweight is a dummy variable *JOGG*. The value is 0 if the municipality did not implement the JOGG program (non-JOGG) and is 1 if the municipality did implement the program (JOGG). The website of JOGG lists which municipalities implemented the JOGG program and it was registered in what year JOGG was implemented (77). Data of the year of implementation (*yr_jogg*) was used for descriptive statistics and to calculate a variable (*K*) for the Event Study analysis. Figure 5 shows how many of the total of 353 municipalities have introduced the JOGG program in total per year. In 2013, there were 27 JOGG municipalities. The number of JOGG municipalities gradually increased over time, to 137 in 2019.

Figure 5

Total number of JOGG municipalities from 2013 to 2019.



Note. This graph only shows the total number of JOGG municipalities from 2013 to 2019. In 2010, 2011 and 2012, respectively 5, 5 and 10 municipalities implemented the JOGG program. In 2020, 7 municipalities and in 2021, 3 municipalities became a JOGG municipality.

To control for population characteristics, the average annual disposable income per household in the municipality in 2018, and the proportion of youth in the municipality (4-18) in 2018 were used. Children in families with lower income are more likely to have overweight, and it was controlled for the fraction of youth in the municipalities. This aggregated data at the municipal level was retrieved from publicly available data on the website of the CBS (92).

Income

No publicly available data was on the SES is a municipality was found online. As mentioned earlier, the socioeconomic status is often measured as a combination of income, education and occupation (68). Income can for example be reflected as the personal annual income or the income of a household or family (93). Therefore, the variable of average annual disposable income per household per the municipality (*income)* was included in the dataset. This data was retrieved from the website of the CBS (92). *Income* is measured in 1000 euros. The municipality with the lowest average disposable income (in 1000 euros) has an income of 33.8 per household. The municipality with the highest average disposable income per household has an income of 95.8 per household. As shown in the descriptive statistics in table 1, 50% of the municipalities has an average disposable income of 45.1 or less.

Table 1

Average disposable income per household in the municipality per year									
Percentile	1%	5%	10%	25%	50%	75%	90%	95%	99%
Average disposable income (1000 euros)	35.9	38	39.3	42.1	45.1	48.9	52.3	54.6	73.9

3.3 EMPIRICAL STRATEGY

In this master thesis, municipality-level panel data on the prevalence of overweight among youth over the period 2013 to 2019 was used to explore the effectiveness of the JOGG program. Two models were presented to estimate the impact of JOGG on the prevalence of overweight among young people; (1) a generalized Difference-in-Difference (DID) with variation in treatment timing and (2) an event study.

GENERALIZED DIFFERENCE-IN-DIFFERENCE

To estimate effect of the JOGG on the prevalence of overweight in JOGG municipalities, compared to non-JOGG municipalities, a difference-in-difference (DID) estimation was performed as main analysis. DID is a quasi-experimental research design that is often used to study causal relationships in public health settings (94). The DID has been around since 1855, when John Snow published the results of his DID study (95). The famous results showed that cholera is transmitted through the water supply rather than air.

It was not possible to choose the treatment and control group myself (RCT), instead existing data was used for an observational study. An important limitation of observational studies (panel data) is the need to control for background changes in outcomes that occur with time (96). The DID approach can be applied to address this problem. The DID study design presumes the existence of two groups; it distinguishes between a treatment group and a comparison group that is experiencing the same trends, but is not exposed to the program (96,97). Municipalities can decide themselves to participate in JOGG, so participation was not randomized. In this study, the municipalities that implemented the JOGG program are the treatment group and municipalities that did not implement the JOGG program are used as control group. The strength of the DID approach is that it can deal with time-invariant unobservable omitted variables between groups, and with time-varying omitted variables if they affect treatment and control groups equally. The outcomes before and after the intervention are compared between the treatment group and the comparison group without exposure, which allows to subtract out the background changes in outcomes (96).

The simplest form of the DID design is often presented in a 2 x 2 box. In the two-group two-period DID design, there are only two groups "non-exposed" and "exposed" observed in two time periods, "preexposure" or "postexposure" (97). The outcomes in the preexposure period (1) and postexposure period (2) of the event are compared between the comparison group without exposure (A) and the intervention group with exposure (B) (96). The average treatment effect for the treated subpopulation (ATT) can be estimated from the simple DID analysis as: (B2-B1) – (A2-A1). If there is an association between the implementation of a program and the outcomes, the interaction between the preexposure-postexposure and exposed group-unexposed group variable is significantly different from zero (96).

However, in this thesis, variation across groups that receive treatment at different times is exploited, because JOGG municipalities apply JOGG in different years. Also, the dataset consists of panel data from 2013 to 2019. To deal with the multiple time periods and variation in treatment timing, the generalized DID design was applied. In this thesis, staggered adoption was assumed, meaning that once a municipality implements the JOGG program, they remain JOGG municipality in the following years (98). The model of the generalized DID is shown in equation [1]] (99).

$$Y_{gt} = \alpha + \rho D_g + \gamma_t + \beta T_{gt} + \varepsilon_{gt} \qquad [1]$$

Where:

D_{g} = group dummy. The JOGG dummy accounts for initial differences in groups (JOGG vs non-JOGG areas). This represents the effects of the time-invariant characteristics of group *g* (97)

γ_t = time-dummies. The year dummies represent the combined effects of time-varying, group-invariant factors. The time-fixed effects trace out the common time trend (97)

T_{gt} = treatment dummy. The treatment dummy is 1 if JOGG group *g* is treated in year *t*, and 0 otherwise. The treatment dummy shows the additional effect in the intervention group from the year the intervention is implemented.

ε_{gt} = random error term

Assumptions

There are two main assumptions of the DID analysis. The core assumption in the generalized DID is the *parallel trends assumption* (PTA) (100). This assumption implies that the pre-treatment trends in both groups be parallel before implementation. In the absence of the treatment, the average outcome for the treated and comparison groups would have evolved parallel (101). Difference-in-difference is not able to deal with time-varying factors that differ between the treatment and control group (97). For this study, the parallel trends assumption implies that JOGG and non-JOGG municipalities have similar trends for overweight prior to the introduction of JOGG. Second, generalized DID assumes that the treatment effect is constant over time (102). This is a disadvantage, because previous research found that time after implementation has impact on the effectiveness of the JOGG program (55). To check whether the treatment effect varies over time, complementary to the generalized DID analysis, an event study was performed. An event study estimates is able to show if the treatment effects vary over time (102).

EVENT STUDY

To deal with the constant treatment effect assumption, complementary to the generalized DID, an event study was performed. The event study model allows to explore the dynamic effect of the treatment. All municipalities that implement JOGG are seen together as the treatment group (JOGG group) and were used in the event study. This study allows to explore the trend after the implementation of JOGG over the years, it allows for anticipation before the treatment, and can show whether the impact of the program was persistent (101). This is in contrast to the DID, where constant effect of the treatment is assumed.

The model of the event study is represented in equation [2] (103).

$$Y_t = \gamma_t + \sum_{k=-5}^{5} (\rho_k \times G[K_t = k]) + \sigma I + \tau J + \varepsilon_t \qquad [2]$$

Where:

Y_t = the outcome variable overweight in year t.

K_t = a time to event variable that equals 0 at the year that JOGG was applied into a municipality.

I = the income variable for the municipalitiy

J = the variable that represents the fraction of youth in the municipality.

The variable *K* was created by the year of JOGG implementation minus the year. K=-5 at 5 years before implementation of JOGG, and K=1 at 1 year after JOGG was applied. This explains why the dynamic effect of the treatment can only be explored in the JOGG group and cannot be compared to the group that did not implement JOGG, because it was not possible to calculate the 'time to event' for the non-JOGG municipalities. Municipalities that did not implement JOGG somewhere in time were coded as missing. First, a graph that showed the average prevalence of overweight by the years relative to the implementation of JOGG (*K*) was plotted to visually explore the overweight prevalence in the JOGG group by time relative to the implementation of JOGG. This graph showed only one line, because the prevalence can only be plotted for the group that implemented JOGG.

In the analysis, K=-1 was used as reference category. This means that the coefficients for *K* derived from the regression analysis, showed the increase or decrease in prevalence overweight in the JOGG group relative to the year before the introduction of JOGG. Note that due to progressive implementation of JOGG in the municipalities, not all the municipalities have the same number of pre and post implementation years (e.g., a municipality that implemented JOGG in 2014 has 1 pre-implementation year and 5 post-implementation years). Descriptive statistics showed that there were only 3 municipalities that had 8 pre-implementation years and 5 municipalities with 9 post-implementation years. As a result, only values for K from -5 to 5 were included in the analysis. Also dummy variables for every *year* from 2014 to 2019 were added, with 2013 as reference category. The coefficients of the dummy variables showed the time trend of overweight prevalence in the whole sample, relative to 2013. Additionally, I controlled for fraction youth between 4 and 18 years old in the municipality (*youth*) and average disposable income per household in the municipality (*income)*.

EXTRA HYPOTHESIS

In previous evaluations of JOGG and EPODE, described in chapter two, it was found that SES had impact on the efficiency of the JOGG program. To further explore this impact, the generalized DID and event study were regressed with an if condition for income, in other words if the income was below the 25^{th} or 50^{th} percentile, and above these percentiles. As described in the variables section, income was used to determine whether the impact of JOGG on the prevalence of overweight is differs between SES groups. There was no ambiguity in the literature about the cut-off values for "low-income municipalities", therefore the 25th and 50th percentiles were used as cut-off values. The dummy variables for low-income municipalities (*income_low_25* and *income_low_50)* were defined as low when the annual average disposable income per household in the municipality was below the 25^{th} or 50^{th}, corresponding with an average income below 42,100 and 45,100 respectively. It was defined as middle/high income when the income was higher. First, for both cut-off values it was explored graphically if there were any differences in prevalence of overweight in low or middle/high income municipalities and JOGG or non-JOGG groups. Also, the generalized DID estimation was separately performed for the municipalities belonging to the different income groups (e.g. $<25^{th}$, $>25^{th}$, $<50^{th}$ and $>50^{th}$ percentile).

ASSUMPTIONS AND VALIDITY

Parallel trends assumption

Since the selected municipalities were not randomized, but selected on participation on JOGG (yes or no), the parallel trends assumption is important to test. For example, it could be possible that time-varying omitted variables did not affect JOGG and non-JOGG municipalities equally. In generalized DID, it can be tested whether the parallel trends assumption is satisfied by including lead variables in the model (97). More specifically, in order to test the parallel trends assumption in this study, two lead variables of the *treatment* variable (T_{gt} in equation [1]) were included in the generalized DID model. The model is represented in equation [3].

$$Y_{gt} = \alpha + \rho D_g + \gamma_t + \beta T_{gt} + \chi T_{gt+1} + \eta T_{gt+2} + \varepsilon_{gt} \qquad [3]$$

In this equation, T_{gt+j} represents the lead variables of the treatment variable. Leads (T_{gt+1} and T_{gt+2}) were added to the regression analysis. If the data followed the parallel trends assumption, the coefficients of the two lead variables measure any (placebo) treatment effect before the intervention and therefore should not be different from zero and not be significant. If they are significant, this suggests that there were differences in trends between adopting and non-adopting municipalities prior to implementation of JOGG (e.g. the trends do not run parallel before implementation of JOGG).

The parallel trends assumption was also tested for the extra hypotheses. Instead of two, one lead variable was added to these models.

Event study

As mentioned in the section *Event study,* an event study was performed to check whether constant treatment effect can be assumed.

Validity of standardization-factor of the data per municipality

As described in the section *age standardization,* data on overweight was for some municipalities multiplied by a factor. By doing this, hopefully it was able to better estimate the prevalence of overweight in the municipality among youth aged 4 to 19 years. This was done to make the data more comparable between municipalities, because not all municipalities reported information on the same age groups. To see what the impact is of this factor, the model of the generalized DID is in equation [1]] was re-estimated, with overweight without being multiplied with these factors as dependent variable (*overweight_us*). This outcome is a weighted average per municipality per year of the percentages overweight the municipalities reported.

Standard errors

Since the dataset consists of panel data with multiple groups, a problem that can occur is autocorrelation in the variables and the error term. Autocorrelation refers to the degree of correlation of the same variables between two successive time intervals. Standard errors that are robust to serial correlation were computed in all statistical analysis (104). Besides, (linear) regression models assume that each observation is independent of the others (105). Since data consists of panel data (i.e. the same municipalities were followed over time), and de prevalence of overweight is dependent of the prevalence of overweight in the previous year, standard errors were clustered at the municipality level (106). All analysis were performed using Stata/MP 16.1 for Mac.

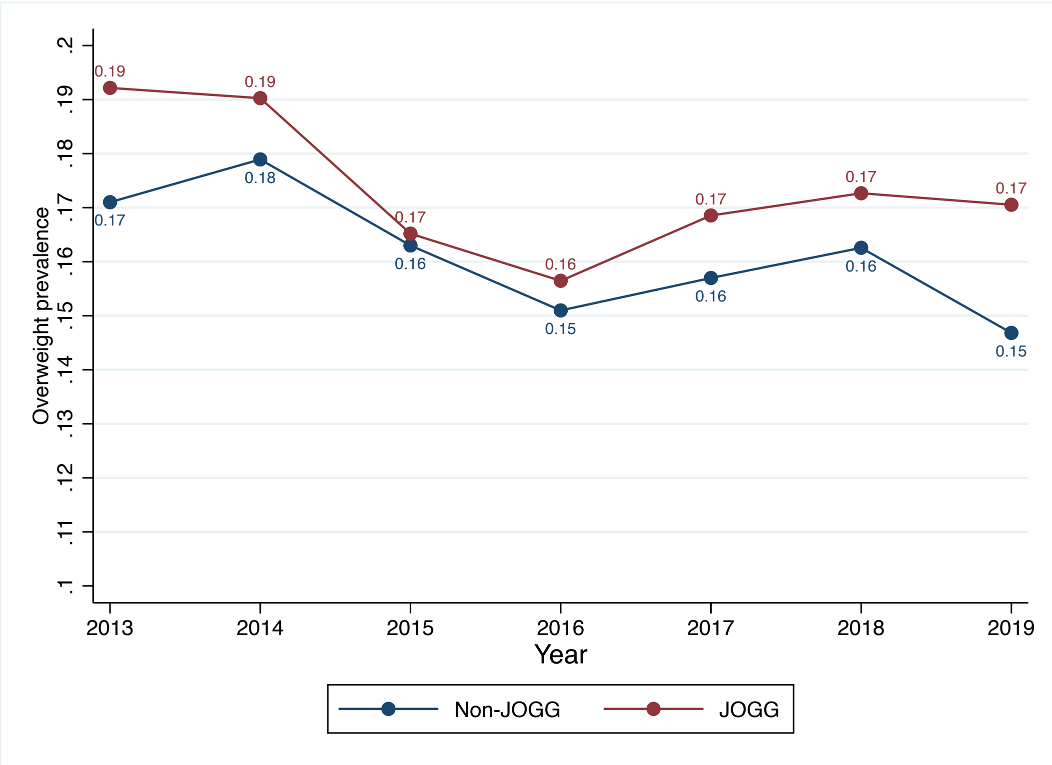
4. RESULTS

4.1 DESCRIPTIVE ANALYSIS

Descriptive analysis examining the role of implementation of JOGG were conducted. First, the mean overweight for JOGG municipalities and non-JOGG municipalities is plotted. Figure 5 plots the mean of the prevalence of overweight from 2013 to 2019 in the treated areas and the control areas. Thus, the control areas are the areas that did not implement the JOGG program and the treated group are the municipalities that implemented the JOGG program somewhere in time. The mean prevalence of overweight in the JOGG municipalities is 0.17 and 0.16 in non-JOGG municipalities.

Figure 5

Evolution of children overweight prevalence in JOGG municipalities and in non-JOGG municipalities between 2013 and 2019.



Note. This graph shows the average overweight prevalence in JOGG municipalities and non-JOGG municipalities. Municipalities that implemented JOGG before 2013 or after 2019 are also included in the JOGG areas and count towards the average over the years.

Overweight prevalence remained higher in all years in JOGG areas compared to non-JOGG areas. The difference in prevalence was the largest in 2019 (2.3 percentage points) followed by 2013 (2.1 percentage points) and the smallest in 2015 (0.2 percentage points). In both groups, there is an upward trend until 2014, a downward trend until 2016, an upward trend until 2018 and finally a downward trend until 2019. The prevalence in 2019 has decreased compared to 2013 in both groups.

4.2 GENERALIZED DIFFERENCE-IN-DIFFERENCE RESULTS

MAIN RESULTS

Results from the DID estimates (equation 1) for the prevalence of overweight are presented in table 2. The results from the DID estimates show that implementation of JOGG significantly increased the prevalence of overweight with 0.018 (p=0.01), suggesting that JOGG implementation did not have an impact on the reduction of overweight. Regarding the time dummies, the results show that, compared to 2013, the prevalence of overweight decreased significantly for 2015, 2016, 2017, 2018 and 2019 (p<0.00). This suggests that for those years, compared to 2013, the mean prevalence of overweight decreased in the whole sample. In 2014, the prevalence increased compared to 2013, this effect is not significant (p=0.59).

Table 2

Generalized difference-in-difference results for the prevalence overweight (2013-2019).

	Prevalence of overweight	
	Coëfficiënt	p-value
DID (JOGG x pre implementation)	0.018[1]	0.01*
Year dummies (reference year = 2013)		
2014	0.002	0.59
2015	–0.019	0.00*
2016	–0.03	0.00*
2017	–0.022	0.00*
2018	–0.018	0.00*

2019	−0.028	0.00*
JOGG	−0.001	0.81

Note. Standard errors clustered at the level of the municipalities (m_id). Without clustered standard errors, DID estimate is also significant. β=0.018 , p=0.00. * significant at 1% significance level ($p < 0.01$), ** significant at 5% significance level ($p < 0.05$).

To validate the standardization-factor to correct for skewness in age per municipality, the analysis was performed with overweight without standardization factor as dependent variable. The results from the DID estimates with overweight without standardization-factor, shows that implementation of JOGG significantly increased the prevalence of overweight with 0.016 (p=0.03).

Parallel trends assumption

As mentioned above, the core assumption of the DID estimate is the parallel trends assumption. When eyeballing the graph (Appendices, figure A) there is no clear parallel trend visible in the years before implementation of JOGG. The results from equation [3] shown in table 3, show that the lead variable of 1 year pre-implementation is statistically significant and different from zero. Therefore, the parallel trends assumption is violated. This implies that the effect of the JOGG program on the prevalence of overweight is partly explained by existence of non-parallel trends. Despite the fact that the p value (p=0.049) is just below the cut-off value for statistical significance, the results should be interpreted with caution. Results from the DID estimate would wrongly suggest that JOGG significantly increased the prevalence of overweight in JOGG municipalities.

Table 3

Generalized difference-in-difference results for the prevalence overweight (2013-2019) with leads for treatment variable.

	Prevalence of overweight	
	Coëfficiënt	p-value
Lead 1	0.017	0.05**
Lead 2	–0.002	0.78

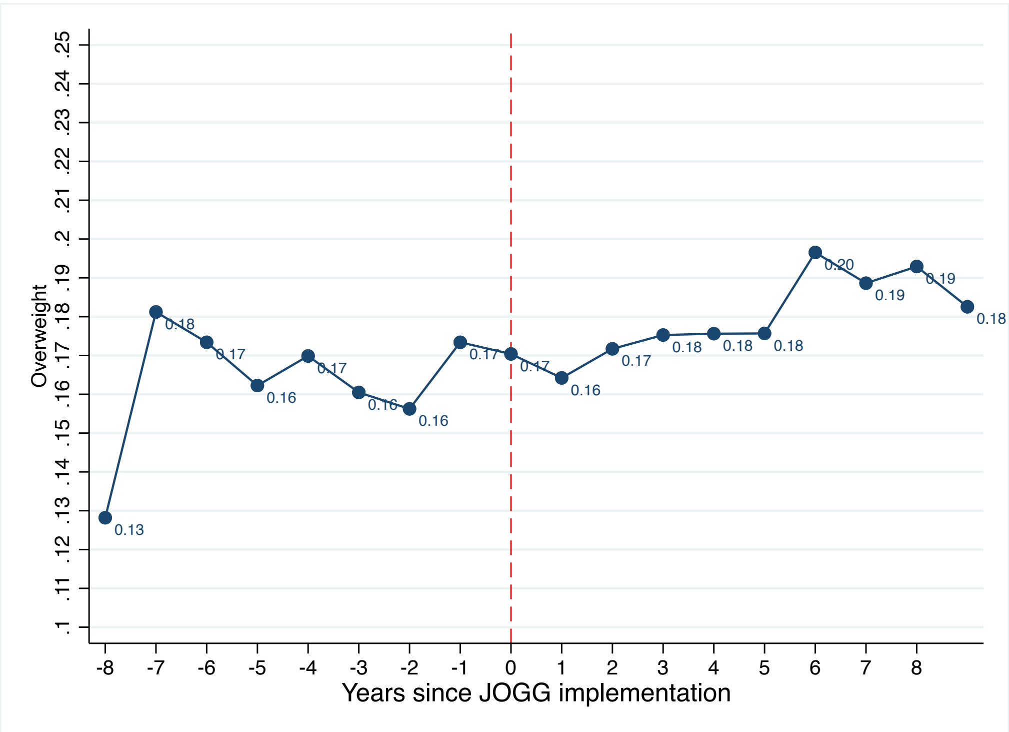
Note. Standard errors clustered at the level of the municipalities (m_id). * significant at 1% significance level ($p < 0.01$), ** significant at 5% significance level ($p < 0.05$). Leads represents the lead variables of the treatment variable. Lead 1 = $treatment_{t+1}$ and lead 2 = is $treatment_{t+2}$.

4.3 Event study

Figure 7 shows the graphical results of the event study for overweight prevalence by the time in years relative to the implementation of JOGG. The graph shows an upward trend of prevalence of overweight after the implementation of the JOGG program.

Figure 7

Graphical results of the event study



The results of the event study analysis are shown in table 4. The coefficients of the dummy variables for the *time relative to the year of implementation* are positive from 2 years after implementation. This is suggesting that, relative to one year before implementation, the mean prevalence of overweight increased in JOGG municipalities 2, 3, 4 and 5 years after implementation. None of these coefficients are statistically significant.

The coefficients of the dummy variables for the year show similar results as the results from the DID analysis, shown in table 3. Except for 2014, all coefficients are negative and statistically significant. This is suggesting that, compared to 2013, the mean prevalence of overweight is decreasing in the whole sample in 2015, 2016, 2017, 2018 and 2019. This decrease is not attributable to the JOGG program.

Table 4

Event study results for the prevalence overweight (2013-2019)

	Prevalence of overweight	
	Coëfficiënt	p-value
Dummy variables for time in years relative to implementation JOGG (reference category = -1)		
-5	–.007	0.47
-4	.006	0.45
-3	–.008	0.25
-2	–.010	0.11
0	–.007	0.24
1	–.006	0.4
2	.007	0.28
3	.004	0.65
4	.008	0.36
5	.009	0.35

Dummy variables for year (reference year = 2013)		
2014	0.00	0.98
2015	−0.026	0.00*
2016	−0.04	0.00*
2017	−0.027	0.00*
2018	−0.03	0.00*
2019	−0.032	0.00*
Youth	0.114	0.68
Income	−0.005	0.00*

Note. Standard errors are clustered at the level of the municipalities (m_id).

* significant at 1% significance level ($p < 0.01$), ** significant at 5% significance level ($p < 0.05$).

4.4 EXTRA HYPOTHESIS

Figure 8

Mean overweight prevalence for JOGG and non-JOGG areas in areas with incomes ≤25th percentile and incomes >25th percentile.

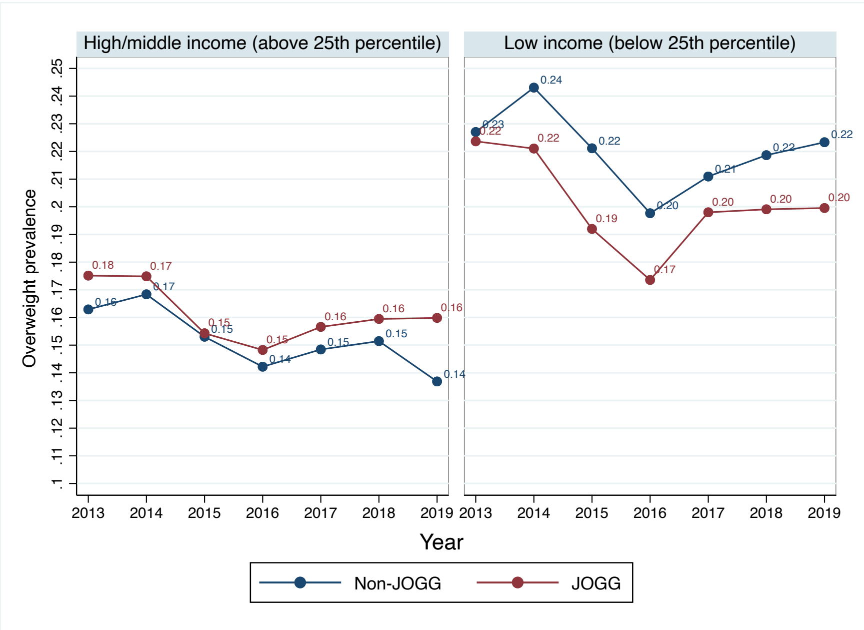
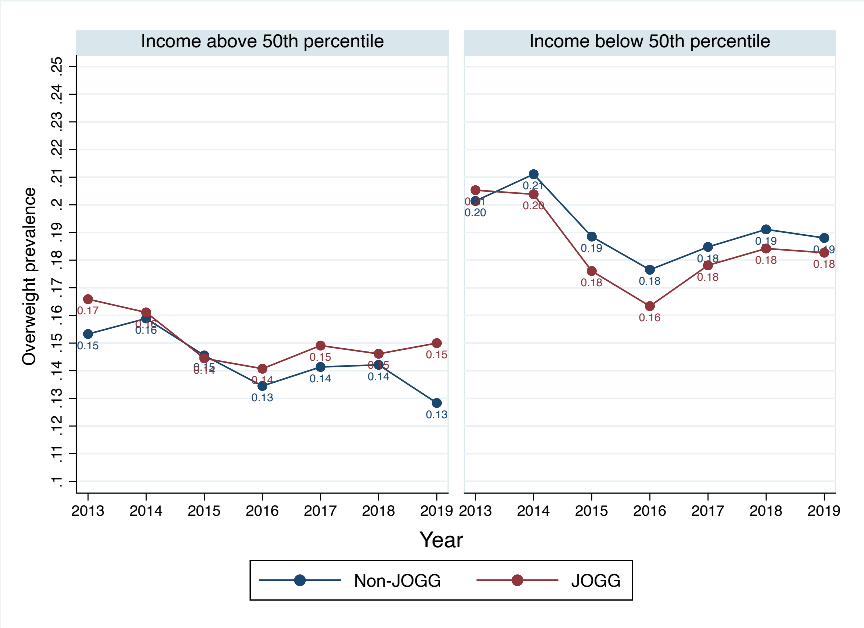


Figure 9

Mean overweight prevalence for JOGG and non-JOGG areas in areas with incomes ≤50th percentile and incomes >50th percentile.



The descriptive statistics shown in figure 8 and 9 show that the mean of overweight prevalence is higher in municipalities with lower average disposable income per household, compared to municipalities with higher income for both cut-off values of 25th and 50th percentile. Also, in municipalities with a low income, the mean overweight prevalence is visibly higher in almost every year in non-JOGG municipalities compared to JOGG municipalities. This is visible in graphs for both cut-off values, but the difference in overweight between JOGG and non-JOGG is the biggest in municipalities below the 25th percentile. In municipalities with middle/high income, the mean overweight prevalence is slightly higher in JOGG municipalities, compared to non-JOGG municipalities.

Table 5

Number and fraction of (non)-JOGG municipalities per income group

		2013	2014	2015	2016	2017	2018	2019
Income <25th percentile	Non-JOGG (n, %)	76 (85.4)	62 (69.7)	49 (55.1)	44 (49.4)	42 (47.2)	39 (43.8)	39 (43.8)
	JOGG (n, %)	13 (14.6)	27 (30.3)	40 (45)	45 (50.6)	47 (52.8)	50 (56.2)	50 (56.2)
Income >25th percentile	Non-JOGG (n, %)	250 (94.7)	222 (84.1)	214 (81.1)	200 (75.8)	192 (72.7)	185 (70.1)	177 (67.1)
	JOGG (n, %)	14 (5.3)	42 (15.91)	50 (18.9)	64 (24.2)	72 (27.3)	79 (30)	87 (33)

Table 5 shows the number of JOGG and non-JOGG municipalities in municipalities with low average disposable income and higher average disposable income. In total, there are 89 municipalities with a low income and 264 municipalities with higher income. From the municipalities with a lower income, a relatively higher fraction has implemented the JOGG program, compared to municipalities with middle/high income for the cut-off value of 25%.

Table 6

Generalized difference-in-difference results for the prevalence overweight (2013-2019) for different income groups

	Prevalence of overweight by income group							
	<25th percentile		<50th percentile		>25th percentile		>50th percentile	
	Coëfficiënt	p-value	Coëfficiënt	p-value	Coëfficiënt	p-value	Coëfficiënt	p-value
DID	0.009	0.45	0.021	0.01**	0.014	0.05**	-0.000	0.98
Lead	0.017	0.135	0.005	0.01**	0.008	0.25	-0.005	0.5

Note. Standard errors are clustered at the level of the municipalities (m_id). * significant at 1% significance level ($p < 0.01$), ** significant at 5% significance level ($p < 0.05$).

Results from the DID estimates for the prevalence of overweight for different income groups are presented in table 6. Only the estimates for incomes $<50^{th}$ percentile and $>25^{th}$ percentile are statistically significant (p=0.01 and p=0.05). The lead estimate is not significant for the municipalities with an income $>25^{th}$ percentile (p=0.25), suggesting that the pre-existing trends for the overweight prevalence in both groups of municipalities are parallel before JOGG implementation. These results suggest that JOGG only has significant effect on the mean prevalence of overweight in municipalities with an average income per household above the 25^{th} percentile and JOGG is not more effective in municipalities with a low income. However, this effect is positive.

5. DISCUSSION & CONCLUSION

5.1 KEY FINDINGS

The results of the difference-in-difference analysis showed a significant increase in the prevalence of overweight after implementation of JOGG. However, the parallel trends assumption was violated, so the results should be interpreted with caution. JOGG did not lead to a decrease in overweight, and if anything, the effect of JOGG is positive.

5.2 INTERPRETATION

This thesis found that JOGG did not contributed to reduction of overweight, and if any, this effect is positive. The generalized difference-in-difference analysis found a significant increase in the prevalence of overweight in municipalities that implemented JOGG in the years after JOGG ($\beta = 0.018$, $p = 0.01$). However, the parallel trends assumption was violated, so these outcomes should be interpreted with caution. The event study analysis did not find any results that suggested the prevalence of overweight was dependent on the duration of the implementation of the program. Instead, the average prevalence of overweight in the JOGG municipalities increased after 2 years of implementation, compared to the year before implementation. This increase was not significant. A possible explanation could lie in the timeframe that was used for this thesis. In the event study analysis, only data of 5 years before and 5 years after implementation was used. An evaluation of EPODE was able to find a causal link between the intervention and a decrease in overweight (107). A follow-up period of more than 10 years was needed to find this significant decrease, because the first years of the intervention were aimed at improving knowledge (107). Another study that suggests that long-term commitment is needed to promote healthy nutrition and physical activity behaviors in youth supports these findings (108). In addition, studies with a shorter follow-up period of 2-3 years and 15 months, found that the proportion of children with a healthy weight did not change over these periods (51,53). Taking this into consideration, it is not surprising that in this thesis no decrease of overweight prevalence was found in the event study analysis after a follow-up of 5 years. When data is available for a limited number of years after implementation of the intervention, it could be considered to use another outcome variable instead of overweight. Preferably variables that demonstrate a change in healthy behavior, resulting in improved health on the long term. For example, the intake of vegetables or fruit, the number of hours of exercise, participation in a sport, or a combination.

Also, the results of this thesis showed that the mean prevalence of overweight in the whole sample decreased over time. This reduction is not attributable to the effectiveness of the JOGG program. The result of the regression analysis for generalized difference-in-differences and the event showed significant decreases in mean overweight prevalence in the whole sample in 2015 to 2019, compared to 2013. An explanation for this decreasing trend could be that there are other programs implemented in regions in the Netherlands that also aim to reduce overweight. JOGG is often not the only lifestyle-promoting program in the municipality (109). In addition to the JOGG approach, there are about 20 other national initiatives that focus on a healthy lifestyle or a healthy environment for children that may also have or have had an effect on overweight and/or exercise behavior in children (110). In May 2018, 368 municipalities took part in *sports and physical activity in the neighborhood*, and there are 976 primary schools, 215 schools in secondary education and 88 in secondary vocational education with a *healthy school* vignette (4). In this thesis, the effects of local initiatives in the municipalities were not taken into account. Other interventions that have taken place in the municipalities that could have an effect on the overall trend. This overall decreasing trend explains why evaluations that did not use a non-treated comparison group found that overweight decreased after implementation of EPODE or JOGG (52). Evaluations of JOGG and EPODE that do not use a control group, but do see a decrease in overweight, miss the point of an overall decreasing trend. They attribute the decrease in overweight prevalence to the program, while in fact, this downward trend is visible in the whole community. Studies should correct for the trend across the whole sample.

The results of this thesis are in contrast to the results Kobes et al. found, while in fact they used a control group (55). They found that overweight prevalence decreased more in JOGG areas compared to non-JOGG areas. Their empirical strategy can be an explanation for this difference. In this thesis, the generalized difference-in-difference method was used to control for background trends. Kobes et al. tested the differences between JOGG and non-JOGG areas by comparing means in the JOGG cohort and non-JOGG cohort at two points in time (2013 and 2018). When not correcting for initial differences between municipalities, this will lead to biased outcomes. For example, they found that in 2013 the JOGG cohort consisted of children who were living in an area with lower SES. In 2018, their sample consisted of children who are living in a low SES area and children living in a high SES area. It is known that in areas with a lower SES, the prevalence of overweight is normally higher compared to areas with a higher SES. So, when only means in 2013 and 2018 in JOGG areas are being compared, the mean prevalence overweight in JOGG areas will drop anyway when children living in high SES areas start participating in JOGG, regardless of the outcome of the program (55).

5.3 Strengths and limitations

One of the strengths of this thesis is that a dataset was constructed with data on overweight at the municipality-level based on many observations within the municipality. This is in contrast to comparable research by the RIVM, where the sample was based on the health survey and the prevalence of overweight in an area on a few observations per area (56). To date, no other evaluation of JOGG was found that included data of all municipalities in the Netherlands, has a large sample size and takes into account background trends.

Another strength is that the gradual implementation over the years of JOGG in the JOGG municipalities provides us with a 'natural experiment' that allows to compare the JOGG municipalities with the non-JOGG municipalities within the same country. The generalized difference-in-difference method is an appropriate way to correct for initial differences between municipalities. The municipality-level panel data allowed to explore whether the duration of the implementation impacts the effectiveness of JOGG.

Regarding the limitations of this thesis, first, the parallel trends assumption is violated in the main analysis. Therefore, the results of the main analysis should be interpreted with caution. The violation of the PTA could arise because municipalities could choose to register themselves for the program, so no treatment and control group was determined in advance, based on characteristics of municipalities. Time-variant characteristics might be different between the group that implemented JOGG and the municipalities that did not implement JOGG. One way to deal with violation of the parallel trends assumption, is by using synthetic controls. The synthetic control methodology formalizes the selection of the non-JOGG municipalities, making it a suitable control group of the treated group (111). This would be recommended for further research where this assumption does not hold.

In addition, there were some limitations regarding the data. This problem was addressed in some other evaluations (55,56). For thesis specifically, this had some limitations. First, a limitation regarding data is that the dataset that was used for the analysis in this thesis, is based on the assumption that the GGDs report the results of the Youth Health Monitor and the measurements of the school nurse well on the websites. The GGDs calculated the percentage of overweight and had to store the information themselves. Some GGDs explicitly stated that cut-off values of Cole et al. were used to determine whether a child had overweight (7), but not every GGD region reported how they calculated the prevalence of overweight in the municipalities. In principle, this does not affect the results if the municipalities do it consistently in the same way over time – there should still be a decrease in overweight prevalence after JOGG implementation if JOGG is effective. However, to make data more comparable between municipalities, the same way of data processing is important. Further, the outcomes of the Youth Health Monitor are based on self-report of the respondent. In contrast, the school nurse's measurements are less sensitive to bias because this is less sensitive to socially desirable answers or measurement errors. GGD regions often showed the results of both measurements on their website. In the dataset of this thesis, data from both measurements were used. A possible consequence is that the municipalities that only reported results of the Youth Health Monitor may have a lower overweight prevalence than municipalities that reported outcomes of the school nurse's measurements.

Second, due data unavailability it was not possible to perform this analysis using individual data. The study uses aggregated data on municipality-level, and therefore assumes that implementation of the JOGG program will have an effect on all youth of this municipality. No problems were encountered for the main analysis for the reason that JOGG aims to reduce overweight among all youth in the municipalities. If their aim had succeeded, a reduction of overweight prevalence after implementation of JOGG should also be visible on an aggregated level. However, to include individual variables to investigate the impact of JOGG on individuals with different characteristics (i.e. low SES, background, specific areas of the municipality), it is preferred to have data at the individual level. For example, to examine the effect of

JOGG on individuals with a low SES within the municipalities. In contrast to other studies (52,55), the results of this thesis it cannot support that JOGG is more effective in low SES areas (e.g., <25t and <50th percentile). An explanation can be that, due to lack of data on individual level, in this thesis the differences were explored between low- and high-income municipalities, instead of the difference between individuals with lower and higher SES within municipalities. Another explanation might be that in this thesis income was used to determine whether a municipality had a low or high SES, while Kobes et al. had access to data on SES (55).

Third, not all municipalities provided data of overweight prevalence all the same age groups. I tried to correct for this by using a ratio to make the groups more comparable. The ratio was calculated by the overweight percentages per age group for the Netherlands. But after applying the ratio to the different age groups a municipality reports about, there were still differences in BMI in the municipalities in a given year between age groups, but the overweight prevalences within the municipalities between age groups were more comparable. To check the validity of the data, the generalized DID analysis was performed with the dependent variable of overweight without the factor for age-standardization, and similar results were found. Further, no data was available on the prevalence of overweight of municipalities in the GGD region *Zuid-Limburg*, GGD region *Gelderland-Midden* and GGD region *Gooi en Vechtstreek*. Interesting to mention is that during writing this thesis I came across a newspaper article that stated that Zuid-Limburg is still a leader in overweight prevalence in the Netherlands (112). No data on overweight was available for *Zuid-Limburg* and data on JOGG participation of municipalities showed that every municipality has implemented JOGG (109). If data on overweight in municipalities in *Zuid-Limburg* was available, this could potentially have led to other results.

5.4 INTEGRATED APPROACHES

Integrated approaches look promising on paper, but because no convincing results have been found so far in this thesis and other evaluations, I would like to briefly discuss what the literature discusses. As a result of the many determinants involved by developing overweight and obesity, the most effective interventions will not be sufficient to reverse the obesity epidemic individually (63). For now, studies that reported changes in overweight rates, occurred in a context where the intervention focused on more environments, target all age groups, and take a life-course approach

(63,107). Benefits of these interventions were mostly found in social classes that were at a greater risk of overweight (55,107).

From an economic perspective, a relevant question to ask is what the economic benefits of prevention overweight and obesity during childhood are. Like mentioned earlier, it was estimated that if the prevalence of childhood obesity were reduced, extra life years can be gained (45). A study evaluated the effect of obesity prevention on lifetime drug spending and other sector-specific expenditures with a Markov model (113). In contrast to other research that support the idea that prevention of obesity will result in lower health care expenditures, they found substantial additional costs for long-term care. This finding is important to consider for policy makers concerned with the future sustainability of the healthcare system. Also, it was found that changes on a higher policy level are needed to reduce overweight. A recent study of the McKinsey Global Insitute stated that ‘no individual sectors in society, whether they are governments, retailers, consumer-goods companies, restaurants, employers, media organizations, educators, health-care providers, or individuals, can address obesity on their own' (114). Interventions need to rely less on education and personal responsibility of individuals. Instead, to reduce overweight, it was suggested that there is need for multiple actions especially in non-health sectors to reduce overweight (63). For example, reducing default portion sizes in the food industry, changing marketing practices or restructuring the educational environment and urban to facilitate physical activity (114). Most countries did not change their food policy while this is crucial to reduce the prevalence of overweight (114). Although this thesis does not evaluate the effectiveness of integrated approaches itself, it is important to take the aforementioned findings into account when developing new programs that aim to reduce overweight.

5.5 Recommendations

In this thesis, no results suggesting that JOGG reduced overweight in municipalities that after implementation of JOGG were found. This does not mean that overall, JOGG cannot be effective. JOGG’s program is promising, but the effectiveness also depends on several other factors, for example the performance of local stakeholders and on the resources available in a household to be able to change behavior (i.e., sufficient financial resources to buy healthy food or a sports club in the area).

To promote further research, it is recommended that one organization collects large-scale information with health measurements. Preferably, this data is measured at an individual level at fixed times, in fixed age groups, and the data is processed and corrected in the same way. Currently, good quality data is not available for all municipalities, what makes it difficult to compare the outcomes of interventions between municipalities.

For future research on the effectiveness of JOGG, it is recommended that JOGG be re-evaluated after a longer period of time, for example more than ten years. When assessing the effects in the shorter term, it can can be recommended to consider another outcome variable that can more quickly reflect a change in healthy behavior. An increase in a healthy diet or an increase in the number of hours of exercise are examples of variables that reflect healthy behavior. This healthy behavior could lead to a decrease in overweight over a longer period. Unfortunately, alternative measures are not available for every municipality, so these should also be collected. Finally, future research might consider to take into account the effects of other interventions in the municipalities.

5.6 Conclusion

With respect to the aim of this thesis – investigate whether the JOGG intervention reduced the prevalence of overweight among children in JOGG-areas compared to non-JOGG area - no effect of the JOGG program on the reduction of overweight was found, and if any, it is positive. This finding, and of previous research, questions the capacity of JOGG to achieve better weight outcomes in the examined time frame. This underscores the need for more data on municipality-level and research on the effectiveness of JOGG and other EPODE adaptations: half of the municipalities in the Netherlands try to reduce the problem of overweight with an approach for which no convincing results were found.

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APPENDICES

Table A

Cut-off values by Cole et al. for overweight by sex between 2 and 18 years old (7).

	Boy	Girl
Age (years)	Overweight (kg/m2)	Overweight (kg/m2)
2	18,4	18,0
3	17,9	17,6
4	17,6	17,3
5	17,4	17,2
6	17,6	17,3
7	17,9	17,8
8	18,4	18,4
9	19,1	19,1
10	19,8	19,9
11	20,6	20,7
12	21,2	21,7
13	21,9	22,6
14	22,6	23,3
15	23,3	23,9
16	23,9	24,4
17	24,5	24,7
>18	25,0	25,0

Table B

Sample size and overweight prevalence among youth 4-19

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Sample N	6	152	162	213	266	236	226	191	37
Overweight prevalence (%)	19.3	17.8	18.4	16.4	15.3	16.2	16.7	15.4	18.5

Figure A

Visual representation of the trends of overweight prevalence for the cohorts of year of JOGG introduction.