Norwegian University of Life Sciences

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Are neighborhood facilities linked to physical activity and screen time? A cross-sectional study among adolescents.

Er nærmiljøfasiliteter knyttet til fysisk aktivitet og skjermtid? En tverrsnittstudie blant ungdom.

Hedda Wisløff
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Forord

Denne masteroppgaven markerer slutten på to lærerike år ved Norges miljø- og biovitenskapelige universitet. Dette studiet har gitt meg ny kunnskap og forståelse for hva som påvirker helsen vår og hvordan vi som samfunn kan arbeide for å forebygge og fremme helsen til befolkningen. Jeg er takknemlig for alt jeg har fått lære, og folkene jeg har blitt kjent med gjennom studiet.

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Hedda Wisløff

Abstract

Background: Insufficient physical activity is associated with adverse health effects. In Norway, only half of adolescents meet the recommended 60 minutes of daily physical activity, and just above 70% are spending more than three hours daily on screens. The neighborhood environment and its qualities have been found to support physical activity and reduce sedentary time. However, limited research considers the influence of facilities on adolescents' activity behavior, particularly within the Nordic context. Such knowledge is vital in public health work aiming to enhance physical activity engagement and prevent sedentary behavior.

Purpose: This thesis aims to examine the relationships between the availability of different neighborhood facilities and both screen time and physical activity among adolescents.

Method: This thesis applied a cross-sectional design. The sample consisted of adolescents aged 10 to 16 recruited from 20 schools across five municipalities in Eastern Norway (n=734). Information on adolescents´ physical activity levels, screen time, socio-demographical factors, and residential addresses were obtained from baseline data collected in the research project CO-CREATING PUBLIC HEALTH. Access to various neighborhood activity facilities (i.e., schools, playgrounds, physical activity facilities, and open green spaces) was computed within 500- and 1000-meter circular buffers surrounding the residential address of each adolescent using geographical information systems (GIS). Logistic regression analyses were used to investigate associations between neighborhood facilities and both physical activity and screen time.

Main findings: In general, access to neighborhood facilities was associated with higher odds of being physically active five times or more per week in the unadjusted models. However, the significance vanished after adjustment for sociodemographic variables. The exception was access to schools within 1000 meters, which was related to a 71% greater likelihood of being physically active five times or more per week. Adolescents with access to playgrounds and physical activity facilities within 1000 meters of their home were also more likely to spend more than three hours on screen time daily.

Conclusion: This thesis highlights the significance of having access to schools in promoting physical activity among adolescents. However, the influence of access to facilities in the neighborhood for screen time should be more thoroughly considered, and more research is needed to understand the relationship between the neighborhood surroundings and different forms of screen time among adolescents. More research is necessary to determine the impact of facilities within different neighborhood scales on physical activity and screen time.

Sammendrag

Bakgrunn: Utilstrekkelig fysisk aktivitet er knyttet til negative helseeffekter. I Norge oppfyller bare halvparten av ungdommene de anbefalte 60 minuttene med daglig fysisk aktivitet, og over 70% tilbringer mer enn tre timer daglig foran skjermer. Nærmiljøfasiliteter har vist seg å øke fysisk aktivitet og redusere stillesitting. Imidlertid er det begrenset forskning på innvirkningen av fasiliteter på ungdommers aktivitetsatferd, spesielt i en nordisk sammenheng. Slik kunnskap er avgjørende i folkehelsearbeidet med sikte på å fremme fysisk aktivitet og forebygge stillesitting.

Formål: Formålet med denne masteroppgaven er å undersøke sammenhengen mellom tilgang til fasiliteter i nærmiljøet og både skjermtid og fysisk aktivitet blant ungdommer.

Metode: Dette er en kvantitativ tverrsnittstudie. Utvalget bestod av ungdommer i alderen 10 til 16 rekruttert fra 20 skoler i fem kommuner i Øst-Norge (n=734). Informasjon om ungdommenes fysiske aktivitetsnivå, skjermtid, sosiodemografiske faktorer og bostedsadresser ble hentet fra eksisterende data samlet inn i forskningsprosjektet Samskaping av aktive møteplasser (SAM). Tilgang til ulike fasiliteter i nabolaget (dvs. skoler, lekeplasser, fasiliteter for fysisk aktivitet, og åpne grøntområder) ble beregnet innenfor 500- og 1000-meter sirkulære buffere rundt bostedsadressen til hver ungdom ved hjelp av geografiske informasjonssystemer (GIS). Logistiske regresjonsanalyser ble brukt for å undersøke forbindelser mellom nabolagsfasiliteter og både fysisk aktivitet og skjermtid.

Hovedfunn: Generelt var tilgang til nabolagsfasiliteter assosiert med høyere sannsynlighet for å være fysisk aktiv fem ganger eller mer i uken. Imidlertid forsvant signifikansen når det ble justerte for sosiodemografiske variabler. Unntaket var tilgang til skoler innenfor 1000 meter, som var relatert til en 70% større sannsynlighet for å være fysisk aktiv fem ganger eller mer i uken. Ungdommer med tilgang til lekeplasser og fysisk aktivitet fasiliteter innen 1000 meter fra deres bostedsadresse hadde også større sannsynlighet for å bruke mer enn tre timer på skjerm daglig.

Konklusjon: Denne masteroppgaven belyser betydningen av å ha tilgang til skoler for å fremme fysisk aktivitet blant ungdommer. Imidlertid bør innflytelsen av tilgang til fasiliteter i nærmiljøet for bruk av skjerm vurderes grundigere, og det er behov for mer forskning for å forstå forholdet mellom nærmiljøet og ulike former for skjermtid blant ungdommer. Mer forskning er nødvendig for å fastslå virkningen av fasiliteter innenfor ulike nærmiljøskalaer på fysisk aktivitet og skjermtid.

Tables and Figures

Abbreviations

CI Confidence interval

CSV Comma-separated values

FAS Family affluence scale

GIS Geographical Information System

MVPA Moderate-to-vigorous physical activity

NMBU Norwegian University of Life Science

OR Odds ratio

OSM Open Street Map

PA Physical activity

REK Regional Committees for Medical and Health Research Ethics

SES Socioeconomic status

SAM Samskaping av aktive møteplasser

SIKT Norwegian Agency for Shared Services in Education and Research

SPSS Statistical package for social science

WHO World Health Organization

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1 Introduction

Physical activity is well-documented to have numerous health benefits (Posadzki et al., 2020), while insufficient physical activity has been linked to several adverse health outcomes (Carson et al., 2016). Only 50% of Norwegian adolescents engage in the recommended 60 minutes of daily physical activity set by the Norwegian government (Steene-Johannessen et al., 2018). Moreover, over 70% of adolescents spend, on average, more than three hours on screens daily (Bakken, 2022), which could indicate sedentary behavior or physical inactivity (Aubert et al., 2018).

The guidelines for physical activity, developed by the Norwegian Directorate of Health (2022b), recommend increasing the daily amount of time spent on physical activity while decreasing the time spent on screens. This is also prioritized in the governmental action plan for physical activity, which, among others, aims to increase physical activity engagement across the population by developing activity-friendly environments where people live (Ministry of Health and Care Services, 2020). This includes creating and ensuring access to parks, playgrounds, and other facilities for physical activity. Research emphasizes that the built environment can positively affect the time spent on physical activity (Hu et al., 2021; Tcymbal et al., 2020), and that children tend to spend more time on sedentary activities in neighborhoods with limited opportunities for physical activity (Christian et al., 2017). Research has also shown that Norwegian children below the age of 10 that have access to parks, playgrounds, and schools close to home are more physically active than their peers (Nordbø et al., 2019). However, we know less about how access to neighborhood facilities influences adolescents' physical activity levels. Moreover, there is limited research from the Nordic context that considers how the neighborhood environment relates to screen time in adolescence. Such knowledge is essential to inform public health efforts that aim to create healthy populations. Thus, this thesis aims to address the influence of neighborhood facilities on engagement in physical activity and screen time among Norwegian adolescents.

This master's thesis is written as part of the research project CO-CREATING PUBLIC HEALTH, led by the Norwegian University of Life Sciences (NMBU). This research project aims to follow the processes of the establishment and use of meeting places in six selected municipalities in the Eastern part of Norway. Before the establishment, a survey was conducted among adolescents aged 10 to 16, and a post-survey will be carried out after the meeting places are opened for public use. This master's thesis originates from the baseline survey conducted in the municipalities Vestby, Vinje, Trysil, Nordre Follo, and Gjøvik.

1.1 The Structure of the Thesis

This master's thesis is written as a monography. Above, a brief introduction to the topic is presented. The next chapter presents empirical literature and research on the topic, followed by the aim of the thesis. Subsequently, the methods used are described. Then, the results from the statistical analyses are presented. This is followed by a discussion of the results and methodological strengths and weaknesses. Finally, some concluding remarks emphasizing the implications of the findings for public health work are provided.

2 Background

This chapter provides essential background information and empirical research on the relationship between neighborhood facilities and both physical activity and screen time. First, the relevance of addressing physical activity and screen time in a public health context will be presented, and a brief overview of international and national guidelines and recommendations for screen time and physical activity will be provided. Subsequently, statistics on adolescents' screen time and activity levels will be given. The importance of the neighborhood environment as a key context for health promotion and an arena for physical activity will be illustrated through a socio-ecological perspective. Lastly, relevant neighborhood facilities will be described.

2.1 Physical Activity and Inactivity

As mentioned, the government has developed an action plan to increase physical activity engagement across the population (Ministry of Health and Care Services, 2020). Creating activity-friendly environments is one of the measures considered in the action plan. Moreover, new Norwegian guidelines for physical activity in different population groups, including adolescents, were released in 2022. These guidelines, based on the global guidelines provided by the World Health Organization (WHO) (2020), recommend increasing the daily amount of time spent on physical activity while simultaneously decreasing sedentary time, such as spending extended periods in front of screens (Norwegian Directorate of Health, 2022b). Both the action plan and guidelines aim to promote physical activity as an important priority in public health work. Promoting physical activity, for instance, by creating an activity-friendly environment, can play a pivotal role in fostering a healthy population that can participate in society.

Physical activity is a broad term that involves various activities in different settings, including the neighborhood environment (Sallis et al., 2006). Physical activity can be defined as "any bodily movement performed by skeletal muscles that result in a substantial increase in energy expenditure above resting levels" (Nerhus et al., 2011). Physical activity is often classified based on its intensity, frequency, or duration of the activity. These factors provide an overall picture of the individual's physical activity levels (Nerhus et al., 2011). Physical activity can also be defined by how the activity is performed, such as organized or unorganized sports

(Fjørtoft, Kjønniksen, & Støa, 2018). This thesis defines physical activity as any activity that causes the individual to become breathless or sweaty.

Physical inactivity refers to insufficient time spent on physical activity (WHO, 2020), including time spent in sedentary behavior. Sedentary behaviors are "any waking behavior characterized by an energy expenditure ≤1.5 metabolic equivalents while sitting, reclining, or lying" (Tremblay et al., 2017). In research, screen time is often used as a proxy for sedentary behavior (Aubert et al., 2018). Screen time refers to time spent in front of a screen, such as a TV, phone, computer, or tablet (Norwegian Directorate of Health, 2022a). Screen-based activities can be both active and sedentary. Active screen time includes various activities or games requiring movement, exploration of the environment, or cognitive learning (Norwegian Directorate of Health, 2022a). Sedentary screen time refers to screen-based activities that do not require or encourage physical activity, for example, sitting in front of a television, computer, phone, or tablet. This thesis will use screen time as a proxy for sedentary behavior.

2.1.1 Physical Activity and Health

It is well-documented and widely accepted that physical activity is essential for good health throughout life (Posadzki et al., 2020). Being physically active daily has numerous health benefits and can protect against more than 30 diseases (Pedersen & Saltin, 2015). In addition to preventing diseases later in life, physical activity has direct positive health effects for children and adolescents. Physical activity lays the foundation for skill development in childhood and adolescence (Barnett et al., 2022), contributes to improved physical fitness, and positively impacts heart and lung function (Chaput et al., 2020). Furthermore, physical activity is significant for bone health and reduces the risk of fractures and low bone density later in life (Chaput et al., 2020; Mountjoy et al., 2011). Physical activity can also influence mental health and has been linked to improvements in cognitive function and academic performance (Chaput et al., 2020; Janssen & LeBlanc, 2010). A positive relationship between physical activity and self-reported health has also been reported (Zhang, Lu, & Wu, 2020).

Usually, diseases related to low levels of physical activity manifest themselves in adulthood. However, the WHO (2020) emphasizes the importance of promoting physical activity in childhood and adolescence because exposure to risk factors occurs throughout the lifespan. Additionally, healthy habits are often established in childhood and adolescence. Hence, children and adolescents should be encouraged to engage in physical activity as early as possible (Hallal et al., 2006; Ministry of Health and Care Services, 2020). This is also demonstrated by research that has found significant correlations between activity levels in childhood and adolescence and activity levels in adulthood (Hayes et al., 2019; Telama et al., 2005). Furthermore, it has been revealed that levels of physical function remain relatively stable throughout life, and there are positive correlations between physical performance in childhood, adolescence, and adulthood (García-Hermoso, Izquierdo, & Ramírez-Vélez, 2022). Therefore, sufficient physical activity in childhood and adolescence is crucial for good health.

On the contrary, insufficient physical activity and excessive sedentary behavior, such as spending too much time in front of screens, are widely known to increase the risk of diseases like heart attacks, cancer, and type 2 diabetes (Carson et al., 2016), as well as obesity (Chaput et al., 2020). Although screen time can be performed while being either sedentary or physically active, it has generally been associated with various negative health outcomes among children and adolescents (Aubert et al., 2018) and is considered a behavior that can contribute to a sedentary lifestyle. Passive or sedentary screen use can lead to prolonged periods of sitting, reducing overall physical activity (Norwegian Directorate of Health, 2022a). A systematic review examining the relationship between sedentary behavior and health indicators in children and adolescents has shown that spending more time in front of screens, especially with TV viewing and video games, is associated with unfavorable body composition and lower fitness (Carson et al., 2016). Furthermore, increased duration or higher frequency of TV viewing has also been associated with elevated clustered cardiometabolic risk scores, while extended screen time and computer usage have been linked to diminished self-esteem (Carson et al., 2016). Research also suggests that excessive screen time negatively affects various protective behaviors essential to health, like getting enough sleep (LeBourgeois et al., 2017), engaging in social interactions (Twenge, Spitzberg, & Campbell, 2019), and participating in physical activity (Melkevik et al., 2010; Sandercock, Ogunleye, & Voss, 2012). A New Zealand study suggests that the effects of screen time on children and adolescents are complex, with both positive and negative effects on socio-emotional skills such as collaboration, self-control, and persistence (Wilkinson, Low, & Gluckman, 2021). However, the nature of these effects depends on how the screen-based activity is designed and implemented, and harmful associations appear strongest when children use non-interactive, non-educational media instead of interacting with people and objects around them. Anyhow, the screen has become an essential part of our daily lives and will likely continue to play a significant role in the lives of today's children and adolescents. Thus, understanding how different factors, including the neighborhood environment, influence time spent in front of the screen is important.

2.1.2 Recommendations and Statistics on Physical Activity and Screen Time

As previously mentioned, the Norwegian Directorate of Health issued new guidelines for adolescents' physical activity levels. The guidelines recommend 60 minutes of daily physical activity and emphasize that adolescents should limit their sedentary time, especially screen time (Norwegian Directorate of Health, 2022b). While there is no conclusive evidence to suggest specific time limits for screen time, research has shown that limiting sedentary behavior can positively impact overall health (WHO, 2020). The Norwegian guidelines do not impose any limitations on screen time. However, they advise reducing sedentary behavior and screen time while increasing physical activity (Norwegian Directorate of Health, 2022a). Due to the harmful effects of excessive screen time on adolescents, guidelines have been developed for the first time in Canada, which suggest limiting screen time to two hours daily for children aged five to 17 years (Tremblay et al., 2011).

In 2018, only 40% of girls and 51% of boys aged 15 years in Norway met the requirement of 60 minutes of daily physical activity (Steene-Johannessen et al., 2018). Findings from the Global Matrices provide evidence that declining physical activity levels among children and adolescents is a universal concern (Aubert et al., 2018). Physical inactivity has reached pandemic levels (Kohl et al., 2012), with half of the adolescents not accumulating the recommended physical activity levels (Steene-Johannessen et al., 2018). Marshall, Gorely and Biddle (2006) highlight that adolescents increasingly dedicate more leisure hours to screen time, leading to declined engagement in leisure-based activities, such as physical activity or outdoor play. In the past decade, significant technological advancements have led to increased engagement in screen-based activities among the young population (Oswald et al., 2020). Data from the recent Norwegian youth survey reveals that more than 70% of adolescents aged 13 to 16 years spend, on average, more than three hours daily on screen-based activities (Bakken, 2022), which is a 20% increase compared to the numbers from 2015 (NOVA, 2015). Furthermore, increased access to electronic devices, especially in high-income countries like Norway, threatens overall screen time among children and adolescents (Aubert et al., 2018). According to some research, children and adolescents are sedentary most of the day, regardless of their physical activity levels (Katapally & Muhajarine, 2015). Even though children accumulated more than the recommended level of physical activity of 60 minutes/day on average, they were consistently sedentary most of the day. Katapally and Muhajarine (2015) conclude that children and adolescents are active and sedentary on the same day. Thus, understanding how factors, such as the neighborhood environment, influence the balance between time spent on screens and time spent on physical activity is essential.

2.2 The Neighborhood as An Arena for Physical Activity

Adolescents engage in physical activities in different situations, such as during school hours, everyday activities, and recreational and leisure activities, which occur in settings like the local school or immediate neighborhood surroundings (WHO, 2022). One of the initiatives in the governmental action plan is to prioritize physical activity in public health work at a national level. This initiative aims to integrate physical activity into the local community and land use planning. This includes the development of playgrounds, green spaces, parks, and paths near residential areas where people live (Ministry of Health and Care Services, 2020). As a result, the neighborhood can be developed to serve as an arena for physical activity. Although the action plan was created relatively recently, constructing environments that support and promote physical activity has been an essential part of public health work for a long time. The Ottawa Charter for Health Promotion, developed by WHO in 1986, emphasized the need for supportive environments that facilitate physical activity, such as safe parks, sidewalks, and recreational facilities (WHO, 1986). Moreover, the Shanghai Declaration, an extension of the Ottawa Charter, aimed to promote the development of healthy cities. The declaration also highlighted the importance of designing urban environments that encourage sustainable mobility, walking, and physical activity, and the need for attractive green neighborhoods and accessible play and leisure facilities (WHO, 2017). This clearly shows that the neighborhood environment is an important arena for public health work that supports active living across all ages.

In the next section, the neighborhood will be presented as an arena for physical activity from a socio-ecological perspective. Furthermore, existing research on the relationship between neighborhood facilities, physical activity, and screen time will be presented, with an emphasis on the facilities that this thesis pays attention to.

2.2.1 Definition of the Neighborhood

This thesis assumes a relationship between environmental factors and health-related behaviors. The socio-ecological model (Sallis et al., 2006) is used to understand this assumption better. This model illustrates how various factors can impact an individual's ability to live an active lifestyle. At the center of the model is the individual, their personal characteristics, and their perception of the environment. The next level looks at the individual's behavior, which is influenced by their interaction with the environment. This level also considers different domains of activities in everyday life, such as active transportation, active recreation, occupational activities, and household activities. The level after that identifies the places where physical activity can occur. Access to these places and their features can either promote or inhibit opportunities for physical activity. This level emphasizes the importance of recreational environments like parks, sports facilities, physical activity equipment, and sedentary options. The outer layer of the model consists of policies and guidelines that provide a framework for the levels within. The outermost layer includes information and the natural and sociocultural environments. This model gives insight into how a complex interplay of factors at different levels affects human behavior. Therefore, efforts in several areas will be required to address behavioral change, and various factors will simultaneously impact physical activity and sedentary behavior (Sallis et al., 2006). This understanding is vital for this master's thesis, which only focuses on some aspects of the relationship between the environment and physical activity.

The focus of this master's thesis is to examine the local conditions, which refer to the immediate surroundings or neighborhood (Sallis et al., 2006). The term "neighborhood" includes the physical characteristics of places, including roads, green spaces, and facilities (Ministry of Health and Care Services, 2020), as well as the social aspects of our surroundings, including social meeting places and a sense of safety (Norwegian Directorate of Health, 2014). This thesis focuses on the neighborhood’s physical environment through objective measures. Thus, the social aspects will not be considered in any further detail.

2.2.2 Measuring the Neighborhood and its Facilities Objectively

There have been inconsistencies in the research regarding the size and methodology of objectively measured neighborhoods. Geographic Information Systems (GIS) are commonly used in research studies to objectively measure neighborhoods, using either network or circular buffers or both (Nordbø et al., 2018; Oliver, Schuurman, & Hall, 2007). A network buffer is based on the road network and defines the area where each participant can move along the road within a given distance. A circular buffer, on the other hand, is based on the straight-line distance and measures distances with a radius around the participant's address. However, no established agreement exists on which buffer method is most appropriate for investigating the impact of neighborhood facilities on physical activity or screen time (Oliver, Schuurman, & Hall, 2007). Some studies propose utilizing a network buffer to indicate walking distance and the presence of facilities in the road network (Oliver, Schuurman, & Hall, 2007). Nevertheless, researchers have suggested that network buffers may not be feasible for GIS analyses involving many participants or individuals spread across large geographical areas. This is due to the high demand for data quality when using this buffer type (Nordbø et al., 2018). Regarding the size of the buffer, researchers have used varied distances ranging from a few meters to several kilometers (Nordbø et al., 2018). However, there is no standardized method for selecting appropriate buffer distances due to the lack of empirical evidence. In research, an 800-meter buffer is commonly used (Nordbø et al., 2018), but according to the Ministry of Health and Care Services (2020), facilities should ideally be located within 500 meters of the residential areas for children and 1000 meters for adolescents to ensure easy access to recreational areas in everyday life.

There are no definite methods to objectively determine the neighborhood (Oliver et al., 2016), making it difficult to determine which characteristics are relevant to include in such analyses. However, as previously mentioned, the government's plan for physical activity aims to create neighborhoods that encourage physical activity by providing recreational areas like playgrounds, green spaces, parks, and sports areas near where people live (Ministry of Health and Care Services, 2020). In addition, activity-friendly outdoor areas should be implemented at schools and kindergartens (Ministry of Health and Care Services, 2020). Other studies provide the same information, suggesting that the surroundings should include various facilities, such as parks, play areas, fitness areas, sports areas, green spaces, water, trails, and swings, to promote and maximize physical activity engagement (Padial-Ruz et al., 2021). The facilities selected for this thesis are open green spaces, such as parks and recreation areas, schools, playgrounds, and physical activity (PA) facilities. This choice is based on previous research and the areas where knowledge is lacking, which will be further described in section 2.2.3. The methodology chapter presents a detailed overview of the selected facilities and the methodology used to compute them.

2.2.3 Neighborhood Facilities Impacts on Physical Activity and Screen Time

Our health is influenced by the opportunities our surroundings provide (Wills, Naidoo, & Wills, 2022), and there is a general agreement that the built environment can positively affect the time spent on physical activity (An et al., 2019; Bird et al., 2018; Hu et al., 2021; Tcymbal et al., 2020). Intentionally designing and shaping the environment for active behaviors, such as building appealing green spaces, playgrounds, or parks, can provide opportunities to engage in physical activity (Zhang et al., 2017). However, a systematic review revealed the multifaceted relationship between the built environment and physical activity among children and adolescents (Nordbø et al., 2020). Nonetheless, facility and amenity indices, encompassing factors such as facilities, green spaces, traffic safety, and pedestrian infrastructure, were consistently associated with unspecified physical activity and, to some extent, leisure-time physical activity (Nordbø et al., 2020). Other reviews found that increased neighborhood greenness positively correlated with outdoor playtime among children aged two to 15 (Lambert et al., 2019), and neighborhoods with features including mixed land use were found to be associated with higher or increased physical activity among the general population (Bird et al., 2018). However, the influence of public open spaces on playtime was inconclusive, with some studies indicating no relationship and others suggesting associations between specific outdoor play spaces and playtime duration (Lambert et al., 2019). Furthermore, living in neighborhoods with walkable attributes has been associated with greater moderate-to-vigorous physical activity (MVPA) among adolescents (Shams-White et al., 2021), and accessibility to facilities was a crucial factor that influenced adolescents' physical activity engagement (Hu et al., 2021). Oreskovic et al. (2015) concluded that adolescents were more likely to engage in physical activity and achieve higher activity levels when utilizing outdoor built environments, such as schools, streets, sidewalks, parks, and playgrounds. Additionally, Mitchell, Clark and Gilliland (2016) found that park space and multi-use path space influenced children's MVPA when accounting for individual and neighborhood socio-demographic variables. However, Mitchell, Clark and Gilliland (2016) emphasized the importance of considering the size of the neighborhood influencing a child's physical activity, which may differ according to sex. On the contrary, Prins et al. (2011) observed that the objectively measured environment, including the availability of sports facilities or parks at different buffer sizes, was not significantly associated with adolescent MVPA. Thus, the studies show, to some extent, inconsistencies in the influence of different neighborhood facilities on physical activity engagement, and there is a lack of findings among Norwegian adolescents.

The relationship between neighborhood environments and adolescents' sedentary behavior is complex, with various studies yielding mixed findings. Christian et al. (2017) noted that children tend to spend more time on sedentary activities in neighborhoods with limited opportunities for physical activity. The article further noted that a high number of different youth-related neighborhood destinations were related to a reduction in weekly screen time, especially in girls (Christian et al., 2017). However, the association between objectively measured neighborhood environments and sedentary time in youth has generally been null (McDonald et al., 2012; Timperio et al., 2017; Veitch et al., 2011) or mixed (Hinckson et al., 2017). One study found a reduction in total screen time when participants perceived the neighborhood as physically activity-friendly but found mixed associations when the neighborhood was objectively measured, where several associations were in the unexpected direction (Bejarano et al., 2019). Others observed no significant differences between typologies of children's neighborhood environments and sedentary behavior (Timperio et al., 2017). Canadian research highlights that adolescents aged 12 to 17 in urban areas are significantly less likely to meet the recommended screen time guidelines than their counterparts in rural areas (Manyanga et al., 2022). A different study discovered that urban individuals spend less time sedentary than those living in rural and suburban areas (Bejarano et al., 2019). Thus, the evidence regarding the impact of neighborhood facilities on screen time is inconclusive.

Various researchers have studied the impact of the neighborhood environment on screen time and physical activity simultaneously. A systematic review examining the built environments' impact on physical activity and sedentary behavior among children and adolescents in China found that availability and accessibility in proximity to greenspaces, parks, and recreational facilities were associated with increased physical activity levels and reduced sedentary behavior (An et al., 2019). Other studies found similar associations, where green spaces in the neighborhood can increase physical activity and reduce screen time among boys (Sanders et al., 2015), and the proximity of urban green spaces to one's home is positively related to increased physical activity levels and decreased screen time among children aged seven to 13 (Akpinar, 2017). However, no such correlation was found among adolescents aged 13 to 18 (Akpinar, 2017). Another study emphasized the importance of access to places for physical activity and sports in reducing sedentary behavior (Timperio et al., 2017). In contrast, Hinckson et al. (2017) found that proximity to parks was associated with increased physical activity, but there was no clear association with sedentary time. Carson et al. (2010) found no association when objectively measuring the neighborhood, but neighborhood satisfaction was associated with reduced screen time and increased physical activity among adolescents. Seemingly, there is a lack of evidence regarding the impact of neighborhood facilities on physical activity and screen time, and there is no such evidence from a Nordic context.

3 Aim of the Study and Research Question

As previously described, physical activity and excessive screen time have numerous impacts on health. Physical activity can protect against several diseases, and excessive screen time and sedentary behavior can lead to health issues. Considering that less than 50% of Norwegian adolescents reach the recommended 60 minutes of daily physical activity (Steene-Johannessen et al., 2018) and that 70% have, on average, three hours of screen time daily (Bakken, 2022), identifying factors that can contribute to preventing this trend is significant. Assuming that the neighborhood can function as an arena for physical activity promotion and sedentary behavior reduction (Timperio et al., 2017), building a neighborhood that supports healthy behaviors is essential. To effectively promote physical activity among adolescents, it is crucial to understand which neighborhood characteristics can enhance it.

Accordingly, this thesis aims to examine the relationship between the availability of neighborhood facilities and physical activity and the availability of neighborhood facilities and screen time among adolescents aged 10 to 16. In addition, this thesis aims to examine whether the relationships between the availability of neighborhood facilities and both physical activity and screen time vary according to how the neighborhood is delineated.

4 Method

This chapter presents the methodology that has been applied. First, the study design is described. Then, the chapter provides a detailed account of how the data was collected, obtained, operationalized, and analyzed. The statistical analysis techniques employed are then explained. Finally, the ethical considerations are addressed.

4.1 Study Design

This master's thesis achieved its aims by using a quantitative, cross-sectional design. This design is well-suited for studying the relationships between various quantitative factors while enabling efficient data collection within a relatively short time span (Sverdrup & Sverdrup, 2020). For the purposes of this thesis, survey data, existing map data from Open Street Map (OSM), and Statistics Norway´s centrality index were used, all of which will be further described in the following sections.

4.2 Context of the Study

This study is part of the research project CO-CREATING PUBLIC HEALTH, which aims to provide knowledge on the significance of municipal public health measures by studying the establishment and use of activity spaces for physical and social activities in local communities (Norwegian University of Life Science, n.d.; Tverga, 2021). The activity spaces will be established in the following six participating municipalities: Vestby, Vinje, Trysil, Nordre Follo, Larvik, and Gjøvik. Before establishing the activity spaces, a baseline survey has been conducted, and a post-survey will be carried out after the development is completed and the spaces have been opened to the public. The baseline survey has been conducted in Vestby, Vinje, Trysil, Nordre Follo, and Gjøvik. This thesis gathered data from the baseline survey in these five municipalities to achieve the aims.

4.3 Recruitment of Participants and Data Collection

The target population comprised 5th to 10th graders (aged 10 to 16 years) living in the five participating municipalities: Vestby, Vinje, Trysil, Nordre Follo, and Gjøvik. The participants were recruited through a purposeful sample of schools, and information about the project was communicated both to the head of the school sector in each municipality and to the principals of each selected school. The schools provided computers or tablets, and the survey was scheduled during school hours. The exception was in Gjøvik, where some of the participants responded to the survey at home and some at school. Adolescents in 20 schools across the municipalities conducted the survey. In one school in Nordre Follo, an average calculation of the number of invited adolescents was made, as the exact number was not provided by the school before the deadline. 3494 adolescents were invited to participate, and the total response rate was 25.8%. Table 1 presents further information.

Table 1: *Descriptive information about each participating municipality's data collection and response rate.*

Municipality	Number of schools	Invited	Participants	Response rate
Vestby	2	187	149	79.7%
Vinje	4	234	178	75.6%
Trysil	3	385	167	43.4%
Nordre Follo	6	1421	279	19.6%
Gjøvik	5	1267	130	10.3%

4.4 Study Sample and Analytical Sample

The total number of respondents was 903 adolescents. In the geocoding process, 137 participants were excluded due to missing addresses, resulting in a study sample of 766 participants. Further, participants from uninvited schools, those with addresses outside the municipalities, and participants with missing answers on key variables were excluded. Thus, 734 participants represented this thesis's analytical sample.

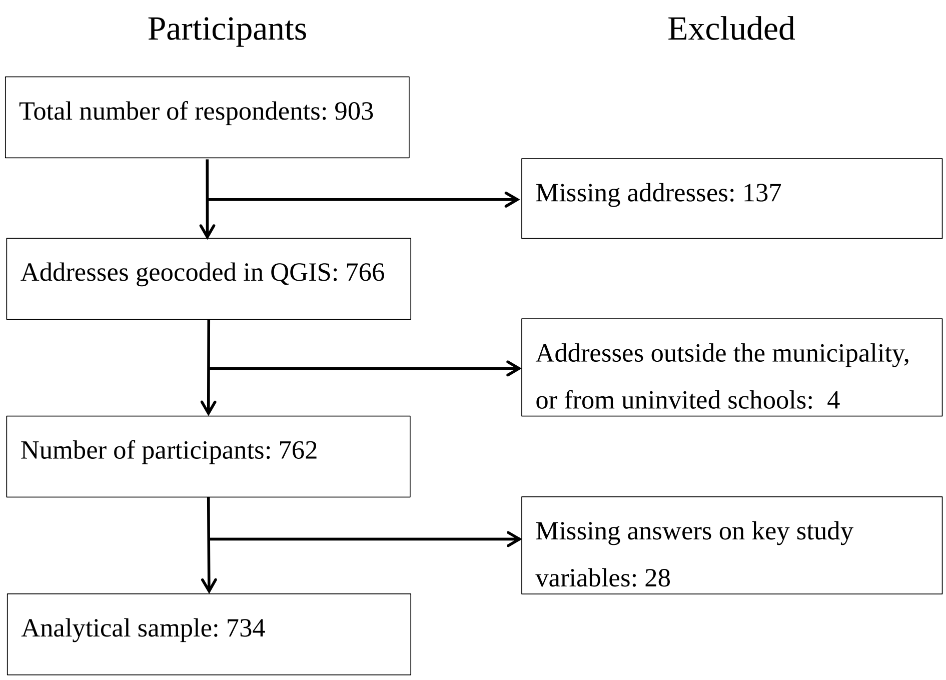

Figure 1: Flow chart depicting the process of deriving the analytical sample.

4.5 Survey Data and Variables Obtained from the Survey

The data was collected through a digital survey using the web-based tool Nettskjema, developed by the University of Oslo (n.d.). The survey included a range of variables related to neighborhood satisfaction and safety, screen time, leisure activities, physical activity, and transportation to and from school. Additionally, the survey included demographic variables such as gender, school, grade level, residential address, and variables to indicate socio-economic status. All variables that were used in this thesis were derived from responses to questions based on the UngData survey (Bakken, 2022).

4.5.1 Residential address

In the survey, participants were asked to write down their residential address, including street name and number, postal code, and city. Participants were not excluded if they did not remember the postal code and city, as it was considered that the street name and number were sufficient to identify the participant. If participants lived in two places, they were asked to provide the address where they lived most. If they lived equally in two places, they were asked to choose one of the addresses. This thesis used the residential address to calculate facilities in each participant's neighborhood. A comma-separated values (CSV) file, including participants' project IDs, was created to connect the GIS variables to the survey. The supervisor used the code key to connect the variables to the corresponding survey participants, making it possible to perform statistical analysis. A detailed description of how neighborhood facilities were calculated will be provided in section 4.7.

4.5.2 Outcome Variables

This thesis used screen time to indicate sedentary behavior and physical inactivity. The outcome variable *screen time* was calculated using one survey variable. The variable addressed screen time on an average day after school and included TV, computers, tablets, and mobile phones. School-related screen activities were excluded. There were seven selectable options: (1) no screen time, (2) less than one hour, (3) one to two hours, (4) two to three hours, (5) three to four hours, (6) four to six hours, and (7) more than six hours. The variable was transformed into a binary variable, where options one to four represented "<3 hours screen time/ day", and the remaining options represented ">3 hours screen time/ day". The cut-off was based on the reference value used in the Ung data survey (Bakken, 2022).

The other outcome variable, *physical activity*, was estimated using a survey question that measures the frequency of strenuous physical activity. The question had six selectable options: (1) never, (2) rarely, (3) once or twice a month, (4) once or twice a week, (5) three to four times per week, (6) at least five times per week. As mentioned above, the recommendations for physical activity among children and adolescents are set to 60 minutes daily (Norwegian Directorate of Health, 2022b). It was, therefore, relevant to transform the physical activity variable correspondingly. None of the options in the variable met these recommendations, but the last option, representing being physically active five times or more per week, was the most representable. The cut-off for this variable was, therefore, set to “active > 5 times/week”, while the other options in the variable were transformed into “active < 5 times/ week”.

4.5.3 Sociodemographic Variables

As previous research on similar topics addresses, it may be relevant to adjust for potential sociodemographic confounders in the analyses (Sanders et al., 2015). Variables from the survey that included information about grade, sex, and Family affluence scale (FAS) score were used as possible confounders in the thesis. The FAS score evaluates adolescents’ socioeconomic status (SES) by asking about family wealth and possessions (Currie et al., 2008). The variables grade and sex were kept in their original form, while the FAS score was calculated using four survey variables. These variables included questions about car ownership, bedroom availability, vacations taken in the last year, and the number of family-owned tablets or computers. A score was calculated based on the answers to at least three of four questions. The FAS score was then categorized into low, middle, and high SES. In previous research, the FAS score has been categorized into five based on the distribution of the participants (Bakken, Frøyland, & Sletten, 2016). This categorization would have been misleading in this survey because the distribution skewed to the right, meaning that the proportion of participants with high SES was larger than that of participants with lower SES. Based on previous theses within the same project, the distinction between low, middle, and high SES was determined by categorizing the total FAS score. A score of 0 – 2.25 was classified as low SES, 2.25 – 3 as middle SES, and a score of 3 was classified as high SES (Heyerdahl, 2023; Randi, 2023). The FAS score was used as a confounder in statistical analysis.

4.6 Centrality Index

Because there are significant differences between rural and urban neighborhoods in Norway, it was essential to consider centrality as a possible covariate in the relationship between neighborhood facilities and both screen time and physical activity. Vinje and Trysil are rural municipalities, while Gjøvik, Nordre Follo, and Vestby are urban (Statistics Norway, 2020). A centrality score was obtained from Statistics Norway's centrality index publication for 2020-2024 to estimate the municipalities' centrality. The centrality index provides data on the centrality of each municipality by measuring the accessibility of workplaces and service functions within 90 minutes by car for residents of each municipality (Statistics Norway, 2020). The different municipalities were categorized into five centrality categories: most central, next most central, middle central, next least central, and least central. Each participant was assigned the centrality category of the municipality where they resided. Descriptive statistics of centrality are presented in the results chapter below. In statistical analysis, centrality was used as a covariate.

4.7 Computation of Independent Variables

QGIS 3.22.14, a Geographical Information System (GIS), was used to estimate the neighborhood facilities. The plugin Open Street Map (OSM), version 2.2.3, was used to extract the different facilities on the map. All these facilities were used separately as independent variables in the statistical analysis.

4.7.1 Geocoding

Before analyzing the facilities located in the neighborhood, the residential address was geocoded in QGIS. The residential address was separated from other personal survey data, and each participant received a project ID. This project ID was used as a linkage key to link the computed environmental variables to the survey data.

4.7.2 Buffer Type and Size

In studies that examine the relationship between neighborhood facilities and different behavioral outcomes, two types of buffers are commonly used: network and circular buffers (Oliver, Schuurman, & Hall, 2007). As mentioned in the background, there are no clear guidelines or recommendations for the buffer type or size most suitable for measuring neighborhood facilities. However, because there were over 700 participants spread across five municipalities, it was considered too complicated to utilize a network buffer (Nordbø et al., 2018). Therefore, a circular buffer was more appropriate in this study. Every buffer was manually quality-checked to ensure no facilities were located beyond reach, such as on the other side of a highway.

Researchers have used different buffer distances in their studies, ranging from a few meters to several kilometers (Nordbø et al., 2018). As previously mentioned, facilities should ideally be located within 500 meters of the residential areas for children and 1000 meters for adolescents (Ministry of Health and Care Services, 2020). This is to ensure easy access to recreational areas in everyday life. Because this thesis included both elementary school students (5^{th} to 7^{th} graders) and lower secondary school students (8^{th} to 10^{th} graders), it was relevant to include both a 500-meter and a 1000-meter distance.

4.7.3 Neighborhood Facilities in Open Street Map

The free service OSM (Open Street Map) was used to assess the different facilities in the neighborhood. OSM displays geographic features on the ground by attaching tags to its data sources. This tagging system allows users to select different features on the map, such as parks, schools, sports fields, and pitches (OpenStreetMap, 2023). To ensure the quality of facilities chosen from OSM, they were compared with a satellite data source, Google Earth.

A selection of relevant facilities was chosen from OSM to estimate neighborhood facilities. Facilities were selected from three categories: *amenity*, *leisure*, and *land use*. *Amenity* refers to facilities used by visitors and residents. *Leisure* is used to label sports and leisure facilities, while *land use* describes the purpose for which an area of land is being used (OpenStreetMap, 2023). As mentioned previously, facilities in the environment, such as parks, recreational facilities, playgrounds, schools, and sports facilities, are important to encourage physical activity in daily life (Ministry of Health and Care Services, 2020; Oreskovic et al., 2015; WHO, 2017). The facilities mentioned above have been utilized in this master's thesis as they are considered crucial for promoting physical activity, according to various studies. Sports fields, pitches, tracks, and other physical activity areas were labeled “PA facilities,” meaning “physical activity facilities.” Open spaces like parks, common areas, and recreation grounds were labeled “open green spaces.” It is worth noting that “open green spaces” only refer to human-built areas intended for recreational purposes, not the amount of greenery or forests in the area. Playgrounds and schools were separate categories. Detailed information about categorizing the facilities selected from OSM is presented in Table 2.

The results of the OSM facilities provided one dataset with points, one with polygons, and one with lines. The line dataset was excluded since it duplicated facilities in the polygon dataset. Points representing gates or entrances were manually removed. In three of the municipalities, some points and polygons were excluded because they represented ski facilities that require an entry fee. One dataset with points was created for each of the categories of facilities presented in Table 2 below. Lastly, the number of facilities within each participant's buffer was counted, which provided two variables for each facility, one representing a 500-meter buffer and one 1000-meter buffer. It is worth noting that Vinje had no designated open green spaces.

Table 2: *Description and categorization of included facilities from OSM.*

Key	**Value**	**Description**
Schools		
Amenity	School	A primary or secondary school (pupils typically aged 6 to 18).
Amenity	Kindergarten	A kindergarten or preschool.
Playgrounds		
Leisure	Playground	A playground: an area designed for children to play.
PA Facilities		
Leisure	Fitness_station	An outdoor facility where people can practice typical fitness exercises.
Leisure	Pitch	An area designed for practicing a particular sport, normally designed with appropriate markings.
Leisure	Sports_centre	A sports center is a district facility where sports take place within an enclosed area.
Leisure	Stadium	A major sports facility with substantial tiered seating.
Leisure	Swimming_area	An area for swimming within a larger body of water (such as a river, lake or the sea) that is marked by rope, buoys or similar.
Leisure	Track	A track for running, cycling and other nonmotorized racing such as horses, greyhounds.
Open Green Spaces		
Leisure	Common	Identify land over which the public has general rights of use for certain leisure activities.
Leisure	Park	A park, usually in an urban (municipal) setting, created for recreation and relaxation.
Landuse	Recreation_ground	An open green space for general recreation, which may include pitches, nets and do on, usually municipal but possible also private to colleges or companies.

The variables representing neighborhood facilities were additionally categorized in Statistical Package for Social Science (SPSS) before performing statistical analysis. As mentioned above, no conclusive evidence exists on how the neighborhood should be measured or categorized. Schools and green spaces were treated as binary variables due to their large size, making it impracticable to build them within neighborhoods. This means that the participants either have access to the facility or not. Since playgrounds and PA facilities are easier to construct within a neighborhood, and some research suggests that a higher quantity of such neighborhood facilities reduces overall screen time (Christian et al., 2017), it is relevant to categorize these facilities into three categories: one representing no access, one representing access to one to three facilities, and the last representing access to more than three facilities.

4.8 Statistical Analysis

The statistical analysis in this thesis was conducted using IBM SPSS statistics version 29.0.2.0 (20). The analytical sample was used for the statistical analyses. Descriptive statistics about screen time, physical activity, sociodemographic variables, and neighborhood facilities were extracted. To estimate the relationship between access to neighborhood facilities and both physical activity and screen time, separate binary logistic regression analyses were conducted for each outcome variable and neighborhood facility. Additionally, adjusted analyses were conducted using the same regression model, which included confounding variables. This was also performed separately for each neighborhood facility and outcome variable. The effect estimates odds ratio (OR) and 95% confidence intervals (CI) were extracted from the analyses, and the significance level was set at 0.05. The analysis results are presented in Tables 5 and 6.

4.9 Ethical Considerations

Ethical considerations have continuously been addressed during the progress. The survey conducted as part of the CO-CREATING PUBLIC HEALTH project was voluntary, and consent from a guardian was required for the adolescent to participate. Sensitive information, such as residential addresses and personal information, was separated and replaced with a code. Only the project manager had access to the code key. In addition, information was stored on internal servers at NMBU in compliance with research ethics guidelines.

This study did not require health-related information from the participants, and a request for approval from the Regional Committees for Medical and Health Research Ethics (REK) was therefore unnecessary. On the other hand, a notification form was submitted to and approved by the Norwegian Agency for Shared Services in Education and Research (SIKT). This application was submitted at the start of the scientific research project, CO-CREATING PUBLIC HEALTH, and was also valid for this specific study (ref. no. 784252).

5 Results

This chapter presents the results of the statistical analyses conducted. The first section provides descriptive statistics for all key variables. This is followed by a presentation of the unadjusted and adjusted binary logistic regression results exploring the associations between neighborhood facilities and both physical activity and screen time. The results for the two outcome variables are presented separately.

5.1 Descriptive Statistics of the Sample

Table 3: *Descriptive statistics of sociodemographic variables and outcome variables.*

	Total (n= 734)
Sociodemographic Variables	**N (%)**
Sex	
Boy	367 (50.0)
Girl	367 (50.0)
Grade	
5th grade	154 (21.0)
6th grade	111 (15.1)
7th grade	105 (14.3)
8th grade	124 (16.9)
9th grade	188 (25.6)
10th grade	52 (7.1)
Centrality	
Most central	232 (31.6)
Next most central	134 (18.3)
Middle central	97 (13.2)
Next least central	139 (18.9)
Least central	132 (18.0)
FAS-score	
Low SES	116 (15.9)
Mid SES	324 (44.1)
High SES	294 (40.1)
Outcome Variables	**N (%)**
Physical activity	
Active <5 times/week	566 (77.1)
Active ≥ 5 times/ week	168 (22.9)
Screen time	
<3 hours screen time/day	350 (47.7)
>3 hours screen time/day	384 (52.3)

Table 3 presents descriptive statistics of the sociodemographic variables. There was an equal number of boys and girls in the sample. Most were 9th-graders (25.6%) and least 10th-graders (7.1%). Nearly one-third of the participants lived in municipalities that were classified as most central (31.6%). Regarding SES, most participants had a FAS score equivalent to middle (44.1%) or high (40.1%) SES. A minority of participants were active five times or more per week (22.9%), and just under half (47.7%) had less than three hours of screen time daily.

Table 4: *Descriptive statistics of accessibility of neighborhood facilities.*

Neighborhood facilities	**Total (n= 734)** N (%)
500-meter buffer	
Access to *open green spaces* within 500 meters	
No	552 (75.2)
Yes	182 (24.8)
Access to *school* within 500 meters	
No	385 (52.5)
Yes	349 (47.5)
Access to *PA facilities* within 500 meters	
No	371 (50.5)
Yes, 1-3 facilities	284 (38.7)
Yes, more than 3 facilities	79 (10.8)
Access to *playgrounds* within 500 meters	
No	467 (63.6)
Yes, 1-3 facilities	215 (29.3)
Yes, more than 3 facilities	52 (7.1)
1000-meter buffer	
Access to *open green spaces* within 1000 meters	
No	349 (47.5)
Yes	385 (52.5)
Access to *school* within 1000 meters	
No	217 (29.6)
Yes	517 (70.4)
Access to *PA facilities* within 1000 meters	
No	217 (29.6)
Yes, 1-3 facilities	210 (28.6)
Yes, more than 3 facilities	307 (41.8)
Access to *playgrounds* within 1000 meters	
No	343 (46.7)
Yes, 1-3 facilities	173 (23.6)
Yes, more than 3 facilities	218 (29.7)

Table 4 provides descriptive statistics of the accessibility of neighborhood facilities calculated using GIS. Within a 500-meter buffer, only 24.8% of the participants had access to open green spaces (e.g., parks or recreational grounds). The proportion of participants with access to open green spaces increased to 52.5% when the buffer size increased to 1000 meters. On the other hand, school accessibility was generally higher, with 47.5% and 70.4% of the adolescents having access within 500 and 1000 meters, respectively. For PA facilities (e.g., pitches, tracks, or stadiums) and playgrounds, over half of the participants (50.5% for PA facilities, 63.6% for playgrounds) had no access to such facilities within a 500-meter buffer. Few participants had access to more than three playgrounds within 500 meters, with a percentage of 7.1. When the distance increased to 1000 meters, the accessibility of more than three playgrounds increased to 29.7%. However, the proportion of participants without playground access was still high (46.7%) at a 1000-meter buffer. Regarding PA facilities, the accessibility of more than three facilities increased from 10.8% within 500 meters to 41.8% within 1000 meters of the residential address.

5.2 The Relationship Between Neighborhood Facilities and Both Screen Time and Physical Activity

5.2.1 Physical Activity

Table 5 presents unadjusted and adjusted regression analysis results for the relationship between access to neighborhood facilities and physical activity. The odds of being physically active five times or more per week were generally higher for participants with access to facilities than those without, with several facilities having significant associations. However, when adjusting for sociodemographic confounders, the odds decreased, and the significance vanished for all facilities, except accessibility to schools within a 1000-meter buffer. For example, participants with access to more than three playgrounds within 1000 meters had significantly higher odds of being physically active five times or more per week compared to those without access, but the significance vanished after adjusting for confounders (OR= 1.54, CI: 0.89, 2.67).

As mentioned, only one variable remained significant after adjusting for sociodemographic confounders. Participants with access to schools within a 1000-meter buffer were 2.16 times more likely to be physically active five times or more per week than participants without access (OR= 2.16, CI: 1.41, 3.32). The odds decreased but remained significant after the adjusted analyses. Participants with access to schools within 1000 meters were now 71% more likely to be physically active five times or more per week than those without access (OR=1.71, CI= 1.23, 2.51).

Generally, the odds of being physically active five times or more per week were higher when participants had access to facilities within 1000 meters compared to 500 meters. This was observed for almost all variables. For instance, participants with access to more than three playgrounds within 500 meters were 32% (OR= 1.32, CI: 0.61, 2.84) more likely to engage in physical activity five times or more per week than those without access. When analyzing a larger buffer size, at 1000 meters, the likelihood increased to 54% (OR= 1.54, CI: 0.89, 2.67). The most remarkable change was observed for access to schools, where the likelihood of engaging in physical activity five times or more per week compared to the participants without access was 35% higher within a 500-meter buffer and 71% higher within a 1000-meter buffer, which also was significant.

Table 5: *Binary logistic regression results on the relationship between neighborhood facilities and physical activity.*

Variable[b]	Unadjusted OR (95% CI)	Adjusted [a] OR (95% CI)
500-meter buffer		
Access to open green spaces within 500 meters		
No	Ref.	Ref.
Yes	1.45 (0.99, 2.12)	1.13 (0.73, 1.74)
Access to school within 500 meters		
No	Ref.	Ref.
Yes	1.76 (1.240, 2.49)**	1.35 (0.88, 2.05)
Access to PA facilities within 500 meters		
No	Ref.	Ref.
Yes, 1-3 facilities	1.57 (1.09, 2.27)*	1.22 (0.77, 1.92)
Yes, more than 3 facilities	1.66 (0.95, 2.90)	1.12 (0.56, 2.07)
Access to playground within 500 meters		
No	Ref.	Ref.
Yes, 1-3 facilities	1.65 (1.14, 2.40)**	1.35 (0.85, 2.13)
Yes, more than 3 facilities	1.50 (0.78, 2.89)	1.32 (0.61, 2.84)
1000-meter buffer		
Access to open green spaces within 1000 meters		
No	Ref.	Ref.
Yes	1.76 (1.23, 2.51)**	1.21 (0.78, 1.87)
Access to school within 1000 meters		
No	Ref.	Ref.
Yes	2.16 (1.41, 3.32)***	1.71 (1.06, 2.77)*
Access to PA facilities within 1000 meters		
No	Ref.	Ref.
Yes, 1-3 facilities	1.41 (0.87, 2.29)	1.11 (0.63, 1.94)
Yes, more than 3 facilities	1.96 (1.27, 3.03)**	1.27 (0.75, 2.15)
Access to playground within 1000 meters		
No	Ref.	Ref.
Yes, 1-3 facilities	1.35 (0.86, 2.11)	1.29 (0.77, 2.18)
Yes, more than 3 facilities	2.10 (1.41, 3.12)***	1.54 (0.89, 2.67)

*Significance level ≤0.05, ***significance level ≤0.001, [a] adjusted for sex, grade, centrality, and FAS score, [b] the reference group of physical activity was set to "Active <5 times/ week".

5.2.2 Screen Time

Table 6 presents unadjusted and adjusted regression analysis results for the relationship between access to neighborhood facilities and screen time. Surprisingly, the odds of having more than three hours of screen time daily were generally higher when participants had access to neighborhood facilities. On the contrary, the odds of having more than three hours of screen time were lower when the participants had access to either open green spaces within 500 meters (OR= 0.85, CI= 0.59, 1.24) or access to schools within 500 meters (OR= 0.96, CI= 0.67, 1.36). However, these associations were not significant and were close to null.

Table 6*: Binary logistic regression results on the relationship between neighborhood facilities and screen time.*

Variable[b]	**Unadjusted** OR (95% CI)	**Adjusted** [a] OR (95% CI)
500-meter buffer		
Access to *open green spaces* within 500 meters		
No	Ref.	Ref.
Yes	1.22 (0.87, 1.71)	0.85 (0.59, 1.24)
Access to *school* within 500 meters		
No	Ref.	Ref.
Yes	1.26 (0.94, 1.68)	0.96 (0.67, 1.36)
Access to *PA facilities* within 500 meters		
No	Ref.	Ref.
Yes, 1-3 facilities	1.29 (0.95, 1.76)	1.14 (0.78, 1.68)
Yes, more than 3 facilities	1.85 (1.12, 3.05)*	1.42 (0.79, 2.53)
Access to *playgrounds* within 500 meters		
No	Ref.	Ref.
Yes, 1-3 facilities	1.72 (1.24, 2.39)***	1.43 (0.96, 2.11)
Yes, more than 3 facilities	1.63 (0.91, 2.91)	1.52 (0.78, 2.96)
1000-meter buffer		
Access to *open green spaces* within 1000 meters		
No	Ref.	Ref.
Yes	1.57 (1.17, 2.11)**	1.02 (0.72, 1.46)
Access to *school* within 1000 meters		
No	Ref.	Ref.
Yes	1.32 (0.96, 1.81)	1.06 (0.73, 1.53)
Access to *PA facilities* within 1000 meters		
No	Ref.	Ref.
Yes, 1-3 facilities	1.31 (0.90, 1.95)	1.27 (0.81, 1.97)
Yes, more than 3 facilities	1.90 (1.33, 2.70)***	1.56 (1.02, 2.40)*
Access to *playgrounds* within 1000 meters		
No	Ref.	Ref.
Yes, 1-3 facilities	1.81 (1.25, 2.61)**	2.03 (1.32, 3.14)***
Yes, more than 3 facilities	1.87 (1.32, 2.62)***	1.47 (0.92, 2.36)

*Significance level ≤0.05, ** significance level ≤0.01, ***significance level ≤0.001, [a] adjusted for sex, grade, centrality, and FAS score, [b] the reference group of physical activity was set to "<3 hours screen time/ day".

There were several significant findings in the unadjusted analyses. For some associations, the significance disappeared when adjusting for sociodemographic variables. This was observed in the following analysis: open green spaces within 1000 meters (OR= 1.57, CI: 1.17, 2.11), more than three PA facilities within 500 meters (OR= 1.85, CI: 1.12, 3.05), one to three playgrounds within 500 meters (OR= 1.72, CI: 1.24, 2.39), and more than three playgrounds within 1000 meters (OR= 1.87, CI: 1.32, 2.62). However, having more than three hours of screen time daily remained significant for two neighborhood facilities. Individuals with access to more than three PA facilities within 1000 meters of their residential address were 1.56 times more likely to have more than three hours of screen time than those without access. Furthermore, the odds of having more than three hours of screen time increased by 2.03 times for individuals with access to one to three playgrounds within 1000 meters than those without access.

Regarding the different buffer sizes, the odds of having more than three hours of screen time daily were generally higher when the participants had access to facilities at a large buffer size of 1000 meters. This is observed for all the facilities except for more than three playgrounds. For this variable, the odds slightly decreased from 1.52 to 1.47 when the buffer increased from 500 to 1000 meters. In the adjusted analyses, none of the variables were significant within the 500-meter buffer, while more than three PA facilities (OR= 1.56, CI: 1.02, 2.40) and one to three playgrounds (OR= 2.03, CI: 1.32, 3.14) were significant within the 1000-meter buffer.

6 Discussion

This chapter presents the study´s main findings, followed by a discussion of the findings in relation to previous research and empirical evidence. Lastly, the study´s strengths and limitations are presented and discussed, ending with a conclusion and argumentation of this thesis's public health relevance.

6.1 Summary of Main Findings

Although the unadjusted analyses revealed associations between access to various neighborhood facilities and both screen time and physical activity, the significance vanished for most facilities after controlling for socio-demographic covariates. The exceptions were for schools, more than three PA facilities, and one to three playgrounds within 1000 meters. Access to schools within 1000 meters of the residential address was significantly associated with being physically active five times or more weekly. Moreover, access to three PA facilities and one to three playgrounds within 1000 meters was found to be significantly associated with spending more than three hours of screen time daily. In general, the odds ratios increased when the buffer size increased, and the significant findings were only observed within the largest buffer size, at 1000 meters.

6.2 Neighborhood Facilities and Physical Activity

The results showed that the odds of being physically active five times or more per week were generally higher for participants with access to neighborhood facilities than those without such access. However, the significance vanished for most of the facilities in the adjusted models. Although very few significant findings were identified, the general pattern of associations found between access to neighborhood facilities and physical activity is in accordance with previous research, suggesting that access to neighborhood facilities positively impacts physical activity engagement (An et al., 2019; Bird et al., 2018; Hu et al., 2021; Lambert et al., 2019; Mitchell, Clark, & Gilliland, 2016; Nordbø et al., 2020; Oreskovic et al., 2015; Shams-White et al., 2021; Tcymbal et al., 2020). Nevertheless, there are inconsistencies in the research regarding what type of facilities significantly influence participation in physical activity (Nordbø et al., 2020). This study adds to this knowledge base in inconsistencies by showing a significant positive relationship between access to school and involvement in physical activity only.

Access to schools within 1000 meters of the participants' homes was significantly associated with engaging in physical activity five times or more per week. This finding aligns with previous research, suggesting that access to schools in Norway is highly important for physical activity engagement (Nordbø et al., 2019). Norwegian schools are commonly used for organized sports and are considered central community arenas (Nordbø et al., 2019). In addition, the school's outdoor area can function as an arena for physical activity (Ministry of Health and Care Services, 2020) and promote unorganized physical activity during school breaks (Haug et al., 2010) or outside school hours. According to the descriptive statistics, more than 70% of the participants had access to schools within 1000 meters, which highlights that schools are places most adolescents have access to. This suggests that the school area can be considered a crucial place for physical activity promotion for all adolescents. In public health work, this can be crucial knowledge.

Although previous research has found inconsistencies in the relationship between facilities and physical activity, it is worth examining why there were no significant findings between facilities like playgrounds or physical activity facilities (PA facilities) and physical activity in this thesis. According to research, facilities' quality and perceived ascetics influence their usage (Kärmeniemi et al., 2018). Therefore, one may question whether the condition of Norwegian facilities is inadequate and discouraging for physical activity engagement. It is also possible that the playground facilities were designed for younger children, which raises the question of whether the facilities were appropriate for the age range of the participants in this thesis. However, the quality of facilities was not measured in this thesis, and the explanations above merely explore the possible reasons for the thesis´s findings.

6.3 Neighborhood Facilities and Screen Time

Surprisingly, when participants had access to facilities, the odds of spending more than three hours of screen time each day were generally increased. However, there were few significant findings in the adjusted analyses, except for access to two to three PA facilities or one to three playgrounds within 1000 meters. These facilities were significantly associated with spending more than three hours of daily screen time. Some research has found the opposite, suggesting that neighborhood facilities, such as green spaces (e.g., playgrounds) or PA facilities, can increase physical activity engagement and reduce screen time (Akpinar, 2017; Christian et al., 2017; Sanders et al., 2015; Timperio et al., 2017). However, some research has found mixed or null associations between the objectively measured neighborhood and screen time (Hinckson et al., 2017; McDonald et al., 2012; Timperio et al., 2017; Veitch et al., 2011), while other studies have found no associations with screen time, even though there were associations with increased physical activity (Carson et al., 2010; Hinckson et al., 2017). This may suggest that the significant findings of this thesis might have additional underlying explanations. Other factors, such as technological advancements, cultural differences, and individual preferences, may also play a role in this complex association. Further studies are needed to better understand these factors and develop more effective measures for examining the built environment's impact on sedentary behaviors like screen time.

Although the intended objective of measuring screen time in this master's thesis was to determine sedentary time, it cannot be excluded that screen time could also have been active. It is important to note that this thesis does not investigate the relationship between physical activity and screen time, but there is an underlying understanding that there might be a connection between time spent on physical activity and time spent being sedentary or inactive, for instance, in front of screens. Some research studying the relationship between screen time and physical activity suggests that increased screen time leads to reduced physical activity (Dalene et al., 2018; Greier et al., 2019; Melkevik et al., 2010; Serrano-Sanchez et al., 2011). However, other research does not conclude that inactivity is due to screen use, despite inactive people spending most of their time in front of screens (Seippel, Strandbu, & Sletten, 2011). Furthermore, a recent study found no associations between screen time and physical activity levels among adolescents aged 10 to 15 (Dahlgren et al., 2021). According to Katapally and Muhajarine (2015), adolescents are both active and sedentary on the same day, which can partly explain the results of this thesis.

Having recreational facilities such as parks, playgrounds, or physical activity facilities nearby makes it easy for adolescents to participate in physical activities like sports, jogging, or biking (Ministry of Health and Care Services, 2020). At the same time, technological advancements and convenient access to screens have made engagement in screen-based activities outside of the home easy (Oswald et al., 2020). Having facilities nearby might enable adolescents to allocate their time more flexibly between physical activity and screen time, leading to increased engagement in both physical activity and screen time. Katapally and Muhajarine (2015) also suggest that despite meeting the average recommended level of physical activity of 60 minutes daily, adolescents remained sedentary most of the day. The findings in this thesis are in accordance with Katapally and Muhajarine´s argumentation, suggesting that adolescents spend time on screens independently of their activity levels. Balancing physical and screen-based activities can be easier when facilities are located near one's home and travel time is minimized. However, this does not fully explain why the odds of spending more than three hours on screen-based activities daily increased when access to facilities increased.

As part of technological development, the use of media, especially social media, has increased. As previously mentioned, data from the recent Norwegian youth survey reveals that more than 70% of adolescents aged 13 to 16 spend an average of three hours daily on screen-based activities (Bakken, 2022), which is a 20% increase compared to the numbers from 2015 (NOVA, 2015). Statistics from the Norwegian Media Barometer from 2021 also show that the trend for using media has increased, and adolescents spend more time engaging in screens than previously (Schiro, 2021). A possible explanation of this thesis´s findings can be related to recent technological advancements, where numerous options are now available on screens. For instance, popular apps like TikTok, Snapchat, and Instagram have emerged, along with interactive games like Pokémon GO. Most of these apps only require a smartphone or tablet, making it convenient to use these media at any time or place of the day. Previously, individuals were required to sit in front of a desktop computer or television to view a screen, but now, screens can be taken anywhere and can provide opportunities for social interactions outside the homes. Moreover, there are more opportunities for interactive screen usage, such as moving through games or social media. Trends play a crucial role in determining how screens are used. For example, in recent years, it has become popular among young people to record themselves dancing and share it on social media. The neighborhood can function as an arena for social interactions (Sallis et al., 2006) and can be an important meeting place for socializing, for instance, through interactive games and content creation on screens. This might explain the significant findings of spending more than three hours of screen time daily when the participants had access to PA facilities or playgrounds within 1000 meters of residential address.

6.4 Associations Within Different Neighborhood Scales

Regarding the neighborhood scales, the odds were generally higher for both outcome variables when the buffer size increased. However, all the significant findings were observed for the largest buffer size, at a 1000-meter radius from the participants´ residential address. In research using GIS to determine the neighborhood objectively, there have been inconsistencies in the methodology (Oliver et al., 2016), making it difficult to correctly compare the results from this thesis to other research findings. However, it is possible to make some assumptions based on the findings.

As previously mentioned, the governmental plan for physical activity highlights the importance of constructing physical activity-friendly neighborhoods ideally located within 500 meters of the residential address for children and 1000 meters for adolescents (Ministry of Health and Care Services, 2020). However, according to an Australian study, children and adolescents travel on average 1736 meters to the park they actually visit, even though the distance to the closest park from their homes on average was 590 meters (Veitch, Salmon, & Ball, 2008). This suggests that proximity to facilities is not necessarily crucial for adolescents' use of facilities, but access to facilities within a satisfactory distance, which may be greater than expected, is more significant. The findings from this thesis may support this suggestion, as the significant findings were only observed at the largest buffer scale. If adolescents travel longer distances to the park they usually visit, examining even larger buffer sizes would have been interesting. One study found that different buffer scales had varying associations with physical activity when investigating the impact of the neighborhood on MVPA (Boone-Heinonen et al., 2010). The study further found that a buffer distance of 3000 meters consistently correlated with physical activity (Boone-Heinonen et al., 2010). Other studies have discovered that different methods of measuring the neighborhood considerably affect the study results (James et al., 2014; Laatikainen, Hasanzadeh, & Kyttä, 2018), which may partially explain inconsistencies in past studies of the built environment and physical activity. Additionally, an increased buffer size may enable access to more facilities, increasing choices and opportunities for physical activities. Therefore, if other buffer sizes or methods were used, there might have been different associations between the built environment and both physical activity and screen time. However, this thesis aimed to examine the immediate neighborhood. A distance greater than 1000 meters might be too far from the residential addresses to be considered part of the immediate neighborhood.

The Norwegian landscape is characterized by mountains and plateaus, resulting in significant differences between rural and urban areas. Distances in rural municipalities are vast, resulting in longer travel times to schools and community areas (Ministry of Local Government and

Regional Development, 2018). In this thesis, Vinje and Trysil were considered rural. In rural municipalities, the participants may travel longer than 1000 meters to reach different facilities, which may lead to different associations between the availability of facilities and physical activity. If rural municipality residents relied on transportation to facilities, factors such as the parents' ability to transport the adolescent would impact the relationship between availability to facilities and both physical activity and screen time. However, since the majority of participants from the rural municipalities lived close to the community center of the municipality, there were few participants who relied on transportation to different facilities. Nevertheless, the centrality of the included municipalities may have impacted the results, even though it was considered a covariate in statistical analysis.

It is possible that other factors, such as the safety and satisfaction level of the neighborhood, may have affected the relationship between the accessibility of facilities and physical activity as well as screen time. Research has shown that neighborhoods with high perceived satisfaction are related to less screen time and more physical activity (Carson et al., 2010). However, it is essential to note that in this thesis, only the objective measurement of the neighborhood was considered. Further research is needed to determine the perceived environment's possible effect on the relationship between the availability of neighborhood facilities and both physical activity and screen time.

6.5 Methodological Strengths and Weaknesses

The following section will discuss the methodology applied in this thesis. First, the study design will be discussed, followed by the internal and external validity.

6.5.1 Study Design

The aim of this thesis was addressed using a cross-sectional study design. This design was chosen due to its descriptive and analytical ability. Analytical cross-sectional studies allow for investigating the relationship between different variables, such as whether different levels of exposure to a factor are associated with differences in outcomes (Wang & Cheng, 2020). Therefore, the study design was appropriate for exploring the associations between the availability of neighborhood facilities and physical activity and between neighborhood facilities and screen time.

In a cross-sectional study, data on exposure and outcome variables are collected simultaneously. This master's thesis utilized both questionnaire- and GIS-based data, enabling information to be gathered from multiple participants in a relatively short period. Additionally, cross-sectional studies are a quick and resource-efficient study design (Wang & Cheng, 2020). Thus, the study design was deemed suitable for addressing the study aim within the imposed time and resource constraints. However, there are some limitations of the cross-sectional design. Cross-sectional studies lack a time dimension because data on both exposure and outcome are collected simultaneously. Therefore, the design cannot be used to establish causal relationships or the direction of observed associations (Wang & Cheng, 2020). Due to the study design, it is difficult to determine whether certain neighborhood facilities influence adolescents' engagement in physical activity and screen time or if other factors contribute. Findings from longitudinal studies support the hypothesis of a causal relationship between factors in the physical environment and physical activity (Kärmeniemi et al., 2018). However, it is important to discuss the possibility of reversed causality. Parents who are physically active may choose to settle in neighborhoods where access to facilities is good rather than vice versa. When parents consciously select areas with good access and opportunities for activity, this can lead to a self-selection bias (Webb, Bain, & Page, 2020). However, it can be argued that designing neighborhoods to support physical activity is essential, regardless of who chooses to settle there. Therefore, cross-sectional studies can increase the knowledge base about the relationship between neighborhood facilities, physical activity, and screen time, even if they cannot be used to establish causal relationships.

6.5.2 Intern Validity

A study's internal validity pertains to whether the results accurately depict the actual conditions within the sample. Three central aspects are considered when assessing internal validity: selection bias, information bias, and confounding (Webb, Bain, & Page, 2020). These aspects will be discussed in the following sections.

Selection bias

Selection bias occurs when those included in the study differ from those not included, resulting in participants not being representative of the study population as a whole (Webb, Bain, & Page, 2020). As participation in the survey was voluntary, there may be a risk of selection bias due to self-selection (Webb, Bain, & Page, 2020). It is well known that those who volunteer to participate in a survey differ from those who do not, as they might be more health-conscious (Webb, Bain, & Page, 2020), for instance, having more interest in physical activity or the neighborhood environment. However, since the adolescents are not of legal age, their participation in the survey is subject to the approval of their guardians. The participating adolescents may, therefore, represent a population based on their guardians' interest in the survey subject. This may lead to selection bias with skewed results, as the participants might not represent the total population. However, it can be speculated that children and adolescents may not be as aware of their health consciousness as adults, which can contribute to a reduced risk of selection bias caused by self-selection.

Another source of selection bias is low response rates (Webb, Bain, & Page, 2020). If a large proportion does not agree to participate, the remaining group may no longer be a truly random sample of the population. A low response rate can affect the generalizability of the results because non-respondents may have systematically different characteristics than the respondents (Webb, Bain, & Page, 2020). The total response rate on the survey in this thesis was 25.8%. This is generally a low response rate, which may have impacted the results and reduced the external validity (see section 6.5.3). We do not have any information about the participants who refused to participate in the survey. However, previous studies have shown that children who do respond to surveys usually come from families with higher socioeconomic status than those who do not respond to the surveys (Boudewijns et al., 2019). It is important to note that most of the children who participated in this master's study belonged to families with relatively high socioeconomic status. As a result, it is necessary to be aware that this could lead to selection bias, and the respondents may differ systematically from non-respondents. This can either over- or underestimate the true association between the relationship between the neighborhood facilities and both physical activity and screen time (Wills, Naidoo, & Wills, 2022). In this thesis, it can be plausible that the low response rate has skewed the results. However, this is not easy to detect or determine, as we do not have any information about those who did not participate.

A strength of the study is that the participants were recruited through schools. In Norway, most children attend public schools, and 95% of children in Norway attended public primary schools in 2022 (Statistics Norway, 2022). This means that the study reaches children of different socioeconomic statuses and immigration backgrounds. Therefore, this increases the chances that the sample will represent the target population and reduce the risk of selection bias. A weakness was that no information letters in English or other languages existed. This may have resulted in an underrepresentation of children whose parents do not understand Norwegian. Additionally, as data were collected in schools, one can assume that the participants representing the same school may answer somewhat similarly and therefore represent the same "population", meaning that the results may be nested (Webb, Bain, & Page, 2020). Nested results may lead to various errors. Multilevel modeling was a possible approach that allowed for examining both individual- and group-level effects on the outcome of interest. However, the model could not be used because it required a sufficient number of schools (level 2) and participants at each school (level 1) (Clarke, 2008; Hox & Hutchison, 2003; Ringdal, Wiborg, & Ringdal, 2022). Although there were enough schools to conduct a multilevel model, there were too few participants within each school. As no measures were taken to avoid nesting, the statistical analysis may have been distorted, leading to incorrect conclusions and potentially misleading interpretations of the data (Clarke, 2008).

Information bias

Information bias is a measurement error that occurs when the information collected from a sample is incorrect (Webb, Bain, & Page, 2020). This thesis aims to avoid common source biases in associations that may arise from using self-reported data for both exposure and outcome by combining self-reported data from questionnaires with objective data calculated using GIS. This is considered a strength (Chum et al., 2019). However, it is essential to note that errors or weaknesses in the questionnaire or GIS data can still be sources of information bias in this master's thesis. The following sections will discuss these potential sources of information bias.

Information about physical activity and screen time is based on self-reported answers on the survey, which can be a source of recall bias (Webb, Bain, & Page, 2020). It is also important to consider that how the survey questions were formulated might introduce information bias, particularly if they require interpretation. For example, the question assessing physical activity was based on the frequency with which an individual engages in physical activities that cause them to become out of breath or sweaty. Regarding physical activity, studies have shown that adolescents tend to over-report their activity levels (Slootmaker et al., 2009). The alternative to self-reporting is objective measurements of activity levels, such as with accelerometers. However, accelerometer measurement of activity levels has certain sources of error, as it requires a lot of logistics and resources. Therefore, as used in this thesis, questionnaire data can be an acceptable alternative for estimating activity levels (Ng et al., 2019). If random participants overestimate their physical activity levels, it can lead to a non-differential misclassification, where the effect estimate can be biased toward null (Webb, Bain, & Page, 2020). However, if only participants with a particular interest in physical activity systematically overestimate their physical activity level, it will lead to a differential misclassification, where the effect estimate can be biased in either direction. The association may then appear stronger or weaker than it actually is (Webb, Bain, & Page, 2020). Overestimating physical activity levels is often influenced by other factors such as social desirability bias, recall bias, or misunderstanding of the question (Webb, Bain, & Page, 2020). Determining whether children and adolescents are susceptible to social desirability bias is difficult. While they may answer similarly to their peers in the same classroom, it is also possible that they do not feel the need to report more physical activity than they actually engage in. However, according to the descriptive statistics, only 22.9% of the participants engaged in physical activity five times or more per week. This contrasts with the findings from the UngKan survey, which estimated the percentage to be around 50% (Steene-Johannessen et al., 2018). It is unclear whether the difference in findings between this study and the UngKan survey is due to the survey participants in this thesis belonging to a less active population or underestimating their level of physical activity. Consequently, it is challenging to determine if the effect estimate has been biased towards or away from null.

Studies have shown that self-reported screen time can either be overestimated (Boase & Ling, 2013; Hodes & Thomas, 2021; Shum et al., 2011) or underestimated (Felisoni & Godoi, 2018; Lin et al., 2015). However, according to a study (Boase & Ling, 2013), it can be challenging to determine the accurate levels of under- and overestimation of screen time. Alternatively, screen time could be objectively measured using features such as "Screen Time" on smartphones, but this is not an accurate measure of the total screen time, as the participants can spend time in front of other devices. As for physical activity, an overestimation or underestimation of screen time would have led to a non-differential misclassification, where the effect estimate would be biased toward null (Webb, Bain, & Page, 2020). If a specific group systematically underestimated screen time, it could lead to a differential misclassification, which can bias the effect estimates in either direction. It is challenging to determine whether the participants over or underestimated screen time or if it was a random or systematic error, similar to the variable measuring physical activity. As the descriptive statistics in the results chapter presented, approximately 50% of children and adolescents spent more than three hours on screens daily. This contrasts with the UngData survey, which reported a 70%. It is essential to note that the UngData survey did not include children aged 10, which may explain the difference in findings. However, it is possible that the participants in the survey underestimated the time they spent on screens, which could have biased the effect estimated toward null. Nevertheless, according to Boase and Ling (2013), when participants were asked to estimate "how often" they spent time on screens using a categorical self-report measure, there were fewer discrepancies in the results. As the survey used a categorical variable to measure screen time, it may have resulted in fewer discrepancies in the results. This indicates a potential strength of the thesis.

As mentioned in the methodology chapter, the variables measuring screen time and physical activity were transformed into binary variables. In binary classification, there is one positive and one negative class; for example, reach recommendations and not sufficiently active (Berrar, 2019). Converting a variable to a binary variable, also called dichotomizing, has a significant drawback in that it fails to consider certain aspects of the outcomes, which can lead to a loss of important information (Altman & Royston, 2006; Berrar, 2019; MacCallum et al., 2002). Moreover, dichotomization can result in underestimating the level of outcome variation between the different groups (Altman & Royston, 2006) and can lead to problems when comparing findings across studies (MacCallum et al., 2002). However, a benefit of dichotomization is that it simplifies the presentation of results and produces meaningful, easily understandable findings (Farrington & Loeber, 2000), which is considered a strength. Therefore, the outcome variables in this thesis were dichotomized and examined only in terms of whether the recommendations were met or not, as it was unnecessary to investigate the various dimensions of the outcomes. A strength of the thesis is that the cut-off for physical activity and screen time was based on recommendations and previous research. However, it is crucial to consider that some participants may have been placed in the wrong category when dichotomizing the outcome variables. This is because the category placement is based on the participant's response at the time of the survey, which might have differed from their response at another time.

Using Geographic Information Systems (GIS) to calculate neighborhood factors provides objective measures for comparison with previous research. This is considered a strength of the study. The use of individual-centered buffers is also a strength because it allows for examining which neighborhood qualities are in close geographical proximity to each participant. This approach is better than using administrative units (such as postal code areas), where challenges may include differences in the size of the areas or participants living on the outskirts, thus having better access to another administrative area (Oliver, Schuurman, & Hall, 2007). However, individual-centered buffers are not individual-specific and may not necessarily capture the areas used by an individual or those they consider as their neighborhood. Therefore, using circular buffers may not accurately represent the area the participants consider as their neighborhood and may include areas out of reach. GPS data or information from participants about where they usually go can be used to calculate this (Hasanzadeh, Broberg, & Kyttä, 2017). In this master's thesis, such information was unavailable, and a generalized definition of neighborhoods based on empirical knowledge was used instead. One challenge in this context is that there is no agreed-upon definition of the neighborhood, and thus, it is uncertain which buffer size and type is most appropriate. However, this thesis used a 500-meter and 1000-meter buffer based on guidelines from the Ministry of Health and Care Services (2020) and a circular buffer due to the large geographical area that was included. The study found significant results only at the largest buffer size. As discussed in section 6.4, it would be worthwhile to investigate the relationship between neighborhood facilities and physical activity/screen time at even larger neighborhood scales or by implementing other buffer types.

Another limitation of this thesis is the use of OSM. As mentioned in the methodology chapter, OSM is a free service that allows every user to tag and select different features on the map (OpenStreetMap, 2023). A general limitation exists in using a free and open service, as it is not quality-ensured compared to other sources such as GeoNorge. However, using OSM provides a nuanced description of the environment, which is considered a strength. As a quality check, the OSM map layer was compared with Google Earth, which showed a relatively high level of agreement. Another limitation of using OSM is the potential for errors in the selection of facilities. The facilities were chosen based on empirical evidence (Ministry of Health and Care Services, 2020; Oreskovic et al., 2015; WHO, 2017) but were selected manually from the quick OSM function in QGIS. Both errors in selecting and categorizing facilities may limit the thesis's internal validity. However, the OSM coding system is simple and gives users a detailed description of the facilities on the map (OpenStreetMap, 2023). This is considered a strength because only facilities that matched the given criteria were selected from the description, ensuring that only relevant facilities were included in the analyses.

Confounding

In analytical studies, the relationship between two variables can be disturbed by confounding factors. Confounders are related to exposure and outcome variables and can affect the effect estimate calculated in regression analyses (Webb, Bain, & Page, 2020). In this master's thesis, background variables such as FAS score, sex, grade, and centrality were controlled for. These variables were selected based on previous research described in the methodology chapter (Sanders et al., 2015). The FAS score, grade, and centrality were considered as potential confounding factors, as they may be related to the exposure variables (neighborhood facilities) through a potential impact on residence, or related to the outcome variables (physical activity/screen time) through an influence on interest in physical activity or screen time. On the other hand, sex was not believed to have such an impact and was included as a covariate. This thesis accounted for potential confounding and covariates by adjusting for sex, centrality, FAS score, and grade in the binary regression analyses. In this thesis, the odds ratio changed when adjusting for confounders and covariates, with most of the significant findings vanished and some remaining significant. Despite adjusting for these variables, there is still a risk of residual confounding, as it is impossible to control all factors that may affect the relationship in epidemiological studies (Webb, Bain, & Page, 2020).

6.5.3 External Validity

In a research context, external validity pertains to the transferability of the results, i.e., whether the findings can be generalized to a larger population than those included in the study (Webb, Bain, & Page, 2020). For this master's thesis, external validity involves determining whether the findings can be applied to all adolescents in Norway or Scandinavia. The survey conducted as part of the Co-creating public health included participants from five different municipalities in Norway, which is considered a strength for the external validity. However, the selection of participants was limited as several schools and grades in each municipality did not participate in the survey. This could introduce biases and limit the study's generalizability to other populations. Nevertheless, the participating municipalities were located in different parts of Norway, which ensured that both urban and rural areas were represented, strengthening the findings' generalizability to other municipalities in the Eastern part of Norway. However, due to the vast differences in nature across Norway, the results may not be generalizable to other municipalities in different parts of Norway, such as in the North. Additional research is necessary to generalize the results to other parts of Norway and Scandinavia.

7 Conclusion and Public Health Relevance

This thesis provides knowledge on the associations between neighborhood facilities and both physical activity and screen time. Access to facilities in the immediate neighborhood surroundings was not found to be related to physical activity and screen time in this sample of Norwegian adolescents. When considering the greater neighborhood area, having access to schools within 1000 meters of home significantly increased the odds of engaging in physical activity five times or more per week. Interestingly, the results also showed that access to PA facilities and playgrounds was related to significantly high odds of spending more than three hours of screen time daily.

When promoting physical activity for public health, the significance of access to school areas is crucial information. It is essential to encourage closer collaboration among researchers, policymakers, planners, and public health professionals during the planning process and solution development to create physical-activity-friendly environments in the school area, and schools nearby where people reside. Additionally, planning and building residential areas near schools may be as important. Meanwhile, the unexpected increase in screen time associated with access to PA facilities and playgrounds raises concerns. Public health interventions need to consider the multifaceted nature of adolescents' behaviors and preferences. Strategies to reduce screen time should be integrated with those promoting physical activity, and interventions should target individual behavior and environmental factors. Additionally, it should be acknowledged that this master's project is a cross-sectional study, and more research using longitudinal study designs is needed to establish causal relationships. This study only included some municipalities in southern Norway, and caution must be taken when generalizing the results to apply to adolescents in other parts of Norway.

Based on the findings, it appears that there might be a complex interplay between the environment and adolescents' behavior, such as spending time on screens. As emphasized in the socio-ecological model, the physical environment is just one of several areas that influence human behavior. Therefore, changes in physical neighborhood factors must be combined with efforts in other areas, such as attitude and awareness campaigns. Moreover, further investigation is necessary to comprehend how distinct forms of screen time, such as active, passive, or social, are associated with the neighborhood. Additionally, standardized methods are needed to measure the built environment, and more research is needed to determine the impact of different facilities on screen time and physical activity at varying neighborhood scales beyond the scope of this thesis. Notably, the findings of this thesis could be valuable knowledge for Vestby, Vinje, Nordre Follo, Gjøvik, and Trysil in their neighborhood planning process.

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