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Impact of COVID-19 pandemic on the diet, lifestyle, and well-being of young Swedes participating in the I.Family study.

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"Courage is Fear

That has said its prayers."

(Karle Wilson Baker)

Abstract

Introduction: Globally, the COVID-19 pandemic has caused social disruptions that have led to changes in our lives. Young people may be especially susceptible to disruptions during their formative years.

Aim: This study aimed to explore the impact the COVID-19 pandemic has had on the diet, lifestyle behaviours, and well-being of young Swedes who participate in the I.Family cohort in Western Sweden.

Methods: This longitudinal investigation included self-reported data on diet, lifestyle, and well-being collected during the pre-pandemic and peri-pandemic periods. The significance of changes between the two examinations was assessed using the paired t-test for continuous variables and the Wilcoxon matched-pairs signed-rank test for categorical variables.

Results: The analytic sample consisted of 198 paired observations ranging from 12 to 21 years of age. A significant decrease in physical activity, lower levels of well-being, a reduction in consumption of fruits and vegetables, and a lower proportion of individuals that ate breakfast daily were observed. Besides, consumption of artificially sweetened beverages and alcohol diminished. Moreover, increased sleep time was observed, alongside a lower frequency of eating out. Fewer individuals had lunch with a friend or colleague, and a higher proportion of individuals had lunch with a family member.

Conclusion: This study suggests several unfavourable changes in the lives of young Swedes during the peri-pandemic period, but also some positive changes. These findings provide some evidence that young people may need interventions that counter the effects the pandemic regulations have had on their lives and should be further monitored.

Keywords: COVID-19; lifestyle; diet; physical activity; well-being; young people.

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Introduction and Relevance

The coronavirus disease (COVID-19) pandemic has caused unparalleled social disruptions and led to significant changes in daily life worldwide. For many, the clinical effects of COVID-19 have been devastating but moreover, the economic repercussions and psychosocial strain have impacted nearly everyone. Among adult populations, it has been demonstrated that the restrictive measures taken to contain the spread of COVID-19 have deteriorated mental health, unfavourably affected well-being, and posed a threat to a healthy lifestyle (Ammar et al., 2020, 2021). Furthermore, stay-at-home orders might have limited exercise opportunities and exerted influence on food choices and eating behaviours, leading to a decrease in physical activity levels and deteriorating dietary patterns (González-Monroy et al., 2021; Stockwell et al., 2021). In many instances, these harmful effects on important lifestyle pillars are, in turn, associated with unwanted weight gain, which might be difficult to manage and can lead to adverse long-term effects, including metabolic disorders (Bakaloudi et al., 2021; Zeigler, 2021). In addition, those that were already overweight are of particular concern since they may potentially face a dual threat of greater weight gain and an increased risk of becoming seriously ill with COVID-19 (Hamer et al., 2020; Heinberg & Steffen, 2021; Kalligeros et al., 2020).

Among younger people, the pandemic's consequences on health and well-being can be equally deleterious. While the clinical effects of COVID-19 on children and youth are usually milder, the peculiar combination of negative feelings such as fear, uneasiness, and boredom, alongside disturbance of everyday routines and social connections, might have strong impacts on psychosocial development, mental health, and eating behaviours (D Hudson, 2022; Mantovani et al., 2021; Ruiz-Roso et al., 2020). Additionally, a decrease in physical activity coupled with an increase in screen time has been reported, and this combination can exacerbate lifestyle damage and may eventually contribute to excessive weight gain (Androutsos et al., 2021; Brzęk et al., 2021; Kenđel Jovanović et al., 2021; Kharel et al., 2022). Furthermore, an investigation of previous epidemics, namely H1N1 (Influenza A), SARS (severe acute respiratory syndrome), and avian influenza, has shown that containment measures can be especially traumatizing and have long-lasting psychological effects on youth (Sprang & Silman, 2013).

Childhood and adolescence are critical stages of human physical and psychological development, and it has been described that health behaviours established during these periods

can perpetuate into adult life (Sawyer et al., 2012). Considering that the measures taken to combat the pandemic have been in place for a lengthy period, the effects on young people's lifestyle and well-being have also been prolonged and may have adverse long-term outcomes, including the development of overweight, an increase in noncommunicable diseases (NCDs), and mental health issues. Accordingly, a higher burden of these illnesses might compound the pressure on health systems, worsen population health status, undermine economic development, and have unpredictable global health impacts. A literature review performed by myself in February 2022 revealed that, while some research has been carried out on the impact of the COVID-19 pandemic on lifestyle, there have been few empirical investigations into this topic in Sweden. Uniquely, the country has been less strict with overall restrictions and closures over time compared to other European countries. Furthermore, to the author's knowledge, no published research has explored the impact of COVID-19 on young Swedes' diet and lifestyle.

Research Aim

The aim of this study was to explore the impact the Covid-19 pandemic has had on the diet, lifestyle behaviours, and well-being of young Swedes who participate in the I.Family cohort in Western Sweden.

Research question

Are there observable changes in diet, lifestyle behaviours, and well-being reported by young Swedes from early 2020 (pre-pandemic period) to 2021 (peri-pandemic period)?

Background and Previous Research

The COVID-19, which is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), first emerged in December 2019 in Wuhan, China. A few weeks later, on 30 January 2020, the outbreak of COVID-19 was declared a Public Health Emergency of International Concern by the World Health Organization (WHO), and further, on 11 March 2020, a pandemic (WHO, n.d.). Considered a global health crisis, as of June 2022 over 500 million confirmed cases of COVID-19 infection have been reported worldwide, which includes over 6 million confirmed deaths (WHO, n.d.). In addition, an increasing number of individuals experiencing persistent or new symptoms after becoming infected with COVID-19 has been reported. This condition, which encompasses a multitude of symptoms including fatigue, breathlessness and cognitive dysfunction is known as long COVID and is still being investigated (WHO, n.d.).

In the aftermath of the outbreak, several pharmacological and non-pharmacological interventions to prevent and mitigate the spread of the virus were announced. Among the non-pharmacological recommendations, physical or social distancing measures were included, and they encompassed isolation and quarantine of sick and exposed individuals, closures of schools, workplaces, and nonessential shops, and bans of public gatherings and unnecessary travels (European Centre for Disease Prevention and Control, 2020). Globally, government policy responses to the pandemic have been diverse. Some countries have imposed strong containment or lockdowns, while others have adopted a less strict approach. Besides, the restrictions have been lifted and reimposed over time according to the spread of the disease in the population (Hale et al., 2021).

COVID-19 infection control measures in Sweden

The first case of COVID-19 in Sweden was reported on 31 January 2020 (Krisinformation [Emergency Information from Swedish Authorities], 2020). Since the onset of the pandemic, the country has relied on a mitigation strategy, has been less invasive, and predominantly remained open compared to other European and neighbouring Nordic countries, as depicted by the COVID-19 Stringency Index (Hale et al., 2021; Roser, 2021). In this regard, Sweden has been publicly criticized by scholars and in the mainstream media (Bjorklund & Ewing, 2020; Claeson & Hanson, 2021). Still, social distancing measures have been implemented, and the main actors responsible for the country's COVID-19 policy have been

the Public Health Agency of Sweden (Folkhälsomyndigheten) and the National Board of Health and Welfare (Socialstyrelsen), which are independent government agencies that have a high degree of autonomy (Laage-Thomsen & Frandsen, 2022).

The pandemic measures were first based on the Swedish Infectious Disease Act of 2004, and later it was approved an amendment to the Infectious Disease Act and Sweden's Emergency Legislation, which gained effect on 18 April 2020. From 10 January 2021, a temporary pandemic law that allowed the government to order the closure of business, among other actions, took effect. This law was intended to be only for eight months but was further extended and applied until 31 May 2022. A notable fact unique to Sweden is that the Swedish constitution limited the enforcement of non-pharmacological measures since it grants the right to free movement to the citizens. Hence, a nationwide lockdown is not allowed, although the Swedish Infectious Disease Act authorises containment strategies for individuals (Laage-Thomsen & Frandsen, 2022; Ludvigsson, 2020). Even though there exists a legal framework to support the national strategy, the Swedish response was mainly based on strong recommendations rather than compulsory restrictions.

The following is a brief description of the main interventions implemented in Sweden. In general, the interventions were defined at the national level and had minimal variation among the country's geographical regions. In March 2020, the first measures took place, and they included advice against unnecessary travel, the recommendation to work remotely, when possible, the recommendation for people over the age of 70 to avoid close contact with others, and the prohibition of public gatherings and events with more than 500 participants. The limitation for public events was later updated for 50 participants but did not include workplaces and schools. From April 2020, visits to elderly care homes were forbidden. From May 2020 onwards, individuals presenting infection symptoms were advised to stay at home and self-isolate. Also in May 2020, there was a recommendation for online teaching for high schools and universities, while the schools for children under the age of 16 have remained open along the course of the pandemic. From November 2020, there were new interventions in bars and restaurants, including the ban of alcohol sales from 22.00 hours and a maximum limit of eight people per table. In December 2020, gyms and public libraries were shut down and remained closed for a few weeks. (Claeson & Hanson, 2021; Ludvigsson, 2020; Wang & Mao, 2021).

Over the year 2021, the restrictions were largely maintained in scope but were eased and reimposed throughout the year, according to the infection rates. Nevertheless, the general

advice on physical distancing and avoidance of social contacts relied largely on voluntary responses and individual responsibility. For example, while many nations required the use of face masks, wearing them has never been mandatory for the general population and it was only suggested from January 2021 in public transportation and in specific situations where keeping distance was not possible (Claeson & Hanson, 2021). The non-mandatory vaccination against COVID-19 started on 27 December 2020 and it has been offered to individuals aged 12 years or older (information from February 2022). Further, on 9 February 2022, nearly all pandemic restrictions were removed in the country. From the beginning of the pandemic to the day the restrictions were lifted, Sweden had reported 16 464 deaths from COVID-19. (Folkhälsomyndigheten [The Public Health Agency of Sweden], n.d.; Ludvigsson, 2020).

Adolescent's health and repercussions on adulthood

Adolescence is a critical life phase marked by both biological and psychosocial transitions, influenced by social determinants at different societal levels, and affected by risk and protective factors. Despite the relevance of this phase in the life course, over the last decades, adolescents' health has improved to a lower degree compared to younger children, and this age group has been neglected in both research and policy areas (Norris et al., 2022; Sawyer et al., 2012). Even though this stage might be regarded as the healthiest period in life, it has been established that lifestyle habits emerging during adolescence can have a sustained effect into adulthood and impact not only an individual's health and well-being but also a country's burden of diseases and economic status (Sawyer et al., 2012). According to Akseer et al. (2020), nearly 70% of premature deaths among adults are attributable to risky health behaviours acquired at a younger age.

In 2019, the Global Burden of Disease Study showed that NCDs were the leading cause of DALYs (disability-adjusted life-years) and deaths among individuals aged 50 years and older, globally. The data follow the same trend in Sweden, where cardiovascular diseases, diabetes, and cancer are among the main cause of death and DALYs for individuals aged 50 years and older (Vos et al., 2020). Given that NCDs are a global health challenge and are recognised as a pressing matter in the Sustainable Development Goals (Bennett et al., 2018), adolescence could, therefore, be characterized as an appropriate time for the prevention of NCDs later in life. Indeed, many risk factors for NCDs are modifiable conditions and lifestyle behaviours that often initiate around adolescence, including overweight and obesity, unhealthy

dietary habits, physical inactivity, smoking, and alcohol consumption (Akseer et al., 2020; Uddin et al., 2020).

Physical activity and adequate nutrition are two significant lifestyle pillars and therefore will be explored in more detail. Worldwide, physical inactivity is a major risk factor for death and disability (WHO, 2018a). The protective effects of a physically active lifestyle against cardiovascular events, metabolic diseases, and mental health issues have been described in the literature (Lee et al., 2012). Nevertheless, the physical activity levels have remained below the WHO recommendations, which are 150 minutes of moderate-intensity physical activity per week for adults, and 60 minutes per day of moderate-to-vigorous intensity for adolescents (WHO, 2018a). Globally, it is estimated that 80% of adolescents do not meet this global advice on physical activity (WHO, 2018a). In the WHO European Region, the physical activity levels are equally low. In Sweden, where the recommendations comply with the WHO guidelines, the prevalence of appropriate physical activity levels among adolescents is 11% (WHO, 2018b).

The association between unhealthy eating and being overweight during adolescence with poor health later in life is well established (Reilly & Kelly, 2011). Moreover, the maintenance of a healthy diet during adolescence is pivotal not only for the prevention of future ailments but also to support physiological growth and development (Norris et al., 2022). Importantly, many contextual factors can influence adolescent eating behaviours, including food systems and food environments, socioeconomic and cultural factors, and social media (Neufeld et al., 2022). According to WHO (2021), the worldwide prevalence of overweight and obesity among children and adolescents aged 5 to 19 years has increased rapidly over the last four decades, reaching 18% in 2016. In Sweden, it was estimated in 2018 that 15% of children aged 11 to 15 years old were overweight or obese. Among the older group, aged 16 to 19 years old, the proportion of overweight and obesity was 21% (Folkhälsomyndigheten, 2021). In this context, several national interventions have been adopted to tackle nutritional issues in Sweden. A well-known example concerning dietary advice for children and adolescents is the plate model, which illustrates the proportions of different food groups that should compose a healthy meal. This strategy has been implemented by the Swedish Food Agency (Livsmedelsverket), which also emphasises physical activity within the scope of its recommendations to maintain energy balance and avoid excessive weight gain (Livsmedelsverket, 2021).

Previous research on the impacts of COVID-19 restrictions on children and youth

The following section provides an overview of the existing literature on the impacts of COVID-19 restriction measures on lifestyle behaviour and well-being among children and youth. In general, previously published studies are limited to cross-sectional surveys that used convenience samples based on social media platforms. Only a few studies have used longitudinal data, and they present different focuses and populations.

Impacts on diet and eating behaviours

Much of the current literature on COVID-19 and lifestyle disruptions has explored the changes in diet and eating behaviours that were driven by the pandemic. Ruiz-Roso et al. (2020) investigated adolescents' dietary trends in Italy, Spain, Chile, Colombia, and Brazil using online questionnaires via social media, and found that the consumption of fruit, vegetables, and pulses increased significantly, while the fast-food intake reduced. Conversely, some negative changes were also reported, including an increased intake of fried and sweet foods. Similar results were found by Androutsos et al. (2021) in another cross-sectional study. The authors evaluated lifestyle changes and determinants of body weight increase among Greek children and adolescents and reported a significant increase in the intake of fresh foods, including dairy products, in addition to a reduction in the consumption of fast food. Besides, the consumption of snacks and sweets was raised during the study period, which was further associated with body weight increase (Androutsos et al., 2021).

An increment in the frequency of intake of fresh foods, including fish and eggs, was also observed among Chinese youth in a retrospective survey distributed by social media platforms, performed by Yu et al., (2021). Moreover, Medrano et al. (2021), in a longitudinal analysis of a cohort of 291 Spanish children aged 8-16 years, showed that the Mediterranean Diet Quality Index for children and teenagers score (KIDMED) improved during the COVID-19 confinement. In another longitudinal study, Munasinghe et al. (2020) investigated the changes in health and well-being among Australian adolescents and reported a decrease in fast food intake. However, no significant change in the consumption of fruit and vegetable was observed.

Impacts on physical activity

Given the importance of physical activity as a lifestyle dimension, it has been the focus of various studies that assessed the impact of COVID-19 confinement. For instance, Tulchin-

Francis et al. (2021), in a cross-sectional investigation using social media and snowballing sampling, examined the effects of the COVID-19 pandemic on the physical activity levels of U.S. children aged 3-18 years. The authors showed a significant decline in moderate-to-vigorous physical activity, notably among high schoolers. No significant change in the levels of light physical activity was observed (Tulchin-Francis et al., 2021). Similarly, lower levels of physical activity among schoolers and adolescents compared to pre-schoolers were reported by Bustos-Arriagada et al. (2021) in a cross-sectional study performed in Chile. Furthermore, in the investigation conducted by Munasinghe et al. (2020) in an Australian cohort, it was observed a significant decline in physical activity and an increment in sedentary activities among young people aged 13-19 years. In another longitudinal research, where the impact on lifestyle behaviours among 267 university students in Spain was investigated by Imaz-Aramburu et al. (2021), no differences in the frequency or intensity of physical activity were observed.

Impacts on body weight

Many studies have suggested that the impacts on diet and physical activity may be translated into body weight changes. In a retrospective survey using online questionnaires, Jia et al. (2021) investigated the impacts on weight status among youth in China. The authors found a significant increment in average body mass index (BMI) among the participants, alongside to increased prevalence of overweight and obesity. Concurrently, the Chinese youth reported a reduction in moderate-to-vigorous physical activity and an increase in sedentary time (Jia et al., 2021). In another cross-sectional study, Kenđel Jovanović et al. (2021) explored the changes in the nutritional status of Croatian children aged 10-15 years during the pandemic. The results showed a significant increase in BMI and overweight among the participants. Besides, it was observed that the participants were less physically active, while the adherence to the KIDMED score was high (Kenđel Jovanović et al., 2021). Moreover, in a prospective study conducted in Turkey, Durmuş & Solak (2021) evaluated changes in the weight status of 58 students aged 11-14 years and found a significant increment in the percentile values between the two measurements over the span of one year. In another study, an investigation of obesity prevalence in a fixed cohort of individuals aged 2 to 20 years in the U.S., Wu et al. (2021) compared three periods from 2018 and 2020. As a result, a higher increment in obesity prevalence during the peri-pandemic period compared to the pre-pandemic period was reported by the authors.

Impacts on sleep patterns, screen time, and well-being

In Italy, a small longitudinal study conducted by Pietrobelli et al. (2020) among 41 obese children showed an increment in screen time during the lockdown. As the pandemic tends to affect different dimensions of lifestyle simultaneously, was also observed reduction in exercise time, an increase in sleep time, and a higher intake of snacks and sugary beverages among the study population (Pietrobelli et al., 2020). In Greece, Morres et al. (2021) investigated levels of well-being and their relationship with lifestyle behaviour among students aged 12-17 years. Using a web survey, the authors found low levels of well-being among adolescents, in addition to inadequate physical activity levels. Moreover, it was demonstrated that healthier eating and adequate exercising predicted improved well-being (Morres et al., 2021). In India, Saxena et al. (2021) performed a prospective study among children aged 9-14 years that were being followed up before the pandemic. The authors showed a significant increase in screen time and a significant decrease in the time spent on outdoor activities.

Munasinghe et al. (2020) also reported a combination of lifestyle and well-being changes among Australians aged 13-19 years, namely an increase in screen time and lower levels of happiness. In a study conducted in Italy, Segre et al. (2021) interviewed 82 students aged 6-14 years and their parents regarding the impacts of confinement. The authors reported high levels of anxiety symptoms alongside changes in sleep routine and higher consumption of junk food. Among Swedish children aged 4-18 years, worry about the pandemic was frequent, particularly regarding the death of family members, according to the results of an investigation performed by Sarkadi et al. (2021). In a study that aimed to compare the impact of the pandemic on daily life in Norway and Sweden, Helsingen et al. (2020) distributed surveys through social media to individuals aged 15 years or older. Among the participants, 15% were from Sweden. The authors found that 50% of the Swedes reported a more sedentary lifestyle and 33% ate more. The number of people that were depressed and sad was higher in Norway than in Sweden. Moreover, 60% of the participants in both nations answered that their lives were on hold during the research period (Helsingen et al., 2020).

Theoretical Framework

Ecological model for adolescent health

The human ecological model considers the manifold levels (micro, meso, and macro) that may exert influence on human behaviour, including individual factors, physical and socio-cultural environment, government, and political and economic structures (Sallis et al., 2008). Moreover, rather than setting people apart from their context, the model emphasises that a comprehensive understanding of health behaviour must contemplate the integration of key contexts and determinants, namely the environment and policies, and how they interact with individual psychosocial factors (Sallis et al., 2008). Admittedly, there has been a growing interest in the influence of macro-level factors on nutrition and physical activity among scholars, acknowledging the effects on health status and health behaviours that might be induced by environmental factors (Ball et al., 2006). This is exemplified by the sharp increase in obesity globally, and the failure of initiatives focusing solely on individual behaviour to tackle this issue, which has highlighted the importance of upstream factors and obesogenic environments in the genesis and maintenance of obesity (Story et al., 2008).

Given that adolescence is a peculiar phase in life, a particular ecological model was suggested for this age group by Blum et al. (2012), where specific factors are nested in each of the levels of influence (**Figure 1**). As depicted in this ecological framework for adolescent health, the integration of the life course dimension into the model is another important element. The life course approach encompasses the comprehension of several factors that influence an individual's life span, recognising that each life period is dependent on the previous one, and considering the socio-cultural and historical context over this trajectory (Hutchison, 2011). This integration is also discussed by Tomlinson et al. (2021), who argue that the life course approach enhances the ecological model by including the time aspect and considering the human development process, specifically how influences and circumstances in earlier stages might reflect on health status later in life.

As the ecological model brings attention to broader macro-level determinants of health, notably to the social and environmental domains, it may constitute a useful platform that provides a holistic view for an initial understanding of changes in young people's health behaviours during the COVID-19 pandemic.

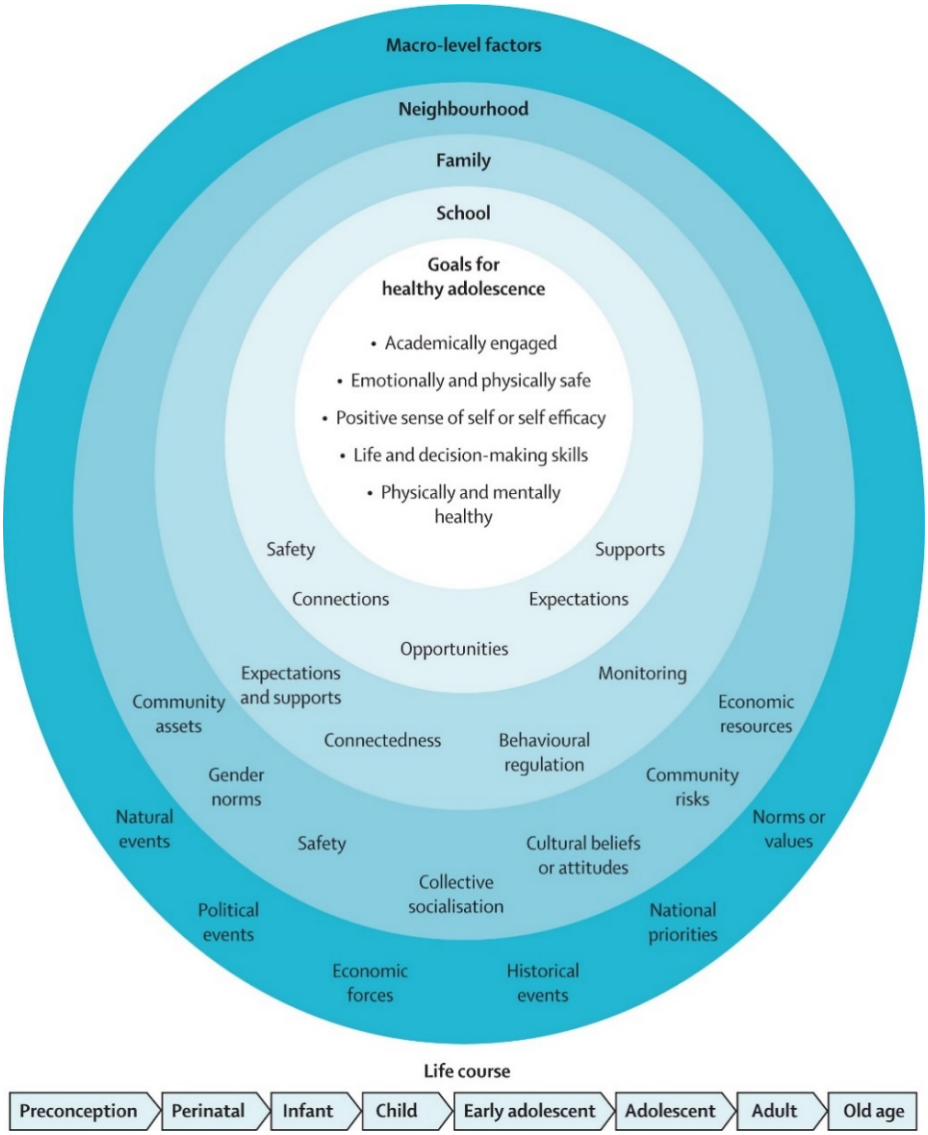

Figure 1: Ecological framework for adolescent health (Blum et al., 2012).

Social determinants of health among young people

The social determinants of health encompass "the conditions in which people are born, grow, live, work and age", according to the definition of the WHO Commission on the Social Determinants of Health (WHO, 2008, p. 01). In this regard, social factors at different levels, including the broader society and the social conditions in which the individual is surrounded, beyond socio-demographic characteristics, can greatly impact health and are crucial determinants of health behaviour and health status (Viner et al., 2012). Furthermore, these determinants can drive health inequalities among young people, including those related to gender, ethnicity, and sexual orientation, which are frequently neglected and hinder the

achievement of their full potential (Patton et al., 2016). Importantly, the individual agency is not disregarded in this conceptual framework; instead, it contemplates the relevance of social context and socio-cultural influences, including family and peer relations, neighbourhood, community, and school environment on youth's choices and behaviours, and in turn on their mental and physical health (Marmot, 2009; WHO, 2012). Considering the different levels of influence, while the structural factors at the country level are appointed as the most powerful determinants of adolescents' health (Viner et al., 2012), some proximal or intermediate social determinants, such as media, peers, and education, also seem to be critical during this phase (Patton et al., 2016). Similarly, the family could be placed among the most important determinants of adolescent health (Viner et al., 2012). Moreover, community-level determinants remain to exert strong influences throughout the life course (Patton et al., 2016).

Health behaviours acquired during a younger age are likely to persist across the lifetime. In this sense, the application of this framework for young people emphasises the role played by risk and protective factors present in more proximal domains, in addition to the social context, on the development of behaviours that can be translated into health status in a later life stage (Sawyer et al., 2012). Therefore, the life course perspective should also be considered in the social determinants of health approach, and the determinants should be addressed across different levels, namely national, community, household, and individual levels, in order to tackle the root causes of ill-health in adulthood (Akseer et al., 2020). From this perspective, although Sweden has a robust welfare system that is designed to ensure access to proper care in case of disease, some societal factors at different levels might have affected young Swedes over the course of the COVID-19 pandemic and influenced their health behaviours. Hence, the social determinants of health might be a helpful framework to comprehend lifestyle changes and their context.

Key Concepts

Child: in general, a child means "every human being below the age of 18 years" (United Nations, 1989, Article 01).

Adolescence: life period "between the ages 10 to 19" (WHO, 2001, p. 01).

Young people: usually alludes to people aged 10 to 24 years (WHO, 2001).

Youth: is defined as "the age cohort 15-24" (United Nations, 2010, p. 10).

Adulthood: It is usually a legal definition that is not universally defined. Many countries, including Sweden, adopt the age of 18 as the age of majority.

Lifestyle: According to the American College of Lifestyle Medicine (n.d.), the key pillars of lifestyle are nutrition, exercise, sleep, stress management, avoidance of risky substances, and healthy relationships. Another definition, from Carlson (2003), refers to "the health behaviours in which a person engages on a daily basis" (p. 1152).

Eating behaviour: the expression encompasses "food choice and motives, feeding practices, dieting, and eating-related problems such as obesity, eating disorders, and feeding disorders" (LaCaille, 2013, p. 641).

Material and Methods

Study design

This study includes secondary, quantitative data from the I.Family study collected at two time points (2020 and 2021). The I.Family study (Determinants of eating behaviour in European children, adolescents, and their parents) was a follow-up survey with children and their families who participated in the IDEFICS cohort (Identification and prevention of dietary- and lifestyle-induced health effects in children and infants). The IDEFICS study was conceived as a European, multicentre, prospective cohort that has been carried out since 2007 in eight countries (Estonia, Germany, Hungary, Italy, Spain, Sweden, Belgium, and Cyprus) with the purpose of understanding and preventing childhood obesity and related disorders. Based on repeated measures of social-environmental, individual, and biomedical parameters, it has been possible to draw conclusions on lifestyle behaviours and health outcomes at a later stage in life for the same research participants (Ahrens et al., 2017). A detailed description of the study design has previously been published (Ahrens et al., 2011).

Study setting and population

The eligibility criteria for recruitment of the baseline IDEFICS cohort, in 2007, included all children aged 2 to 9 years, living in the defined regions, and attending kindergartens and primary schools. In Sweden, the study was performed in the Västra Götaland County, Western Sweden, specifically in Partille, Mölndal, and Alingsås. Parents of the children were invited to participate through a letter delivered via schools or by postal mail. In Sweden, 1809 children had valid data for analysis (Ahrens et al., 2011). For the I.Family study, the IDEFICS children, their siblings, and parents were invited to participate, and the age range of the original participants at the point of departure (2013-2014) was between 5 and 17 years.

The present study focuses solely on longitudinal data collected in Sweden. The sample size calculation for the repeated questionnaires (2021 examination) was based on a study that evaluated the impact of COVID-19 on lifestyle and health-related quality of life in German children and adolescents (Wunsch et al., 2021). Thus, considering a power of 80%, it was estimated that 100 participants would be required to answer the repeated questionnaires in order to detect differences in diet and lifestyle behaviours.

Data collection methods

Data were collected using standardised, self-reported questionnaires developed for the I.Family study distributed at two time points, first in 2020 (referring to the pre-pandemic period), and again in 2021 (COVID-19 impact assessment). The questionnaires were uniquely age-appropriate for adolescents (12-17 years old) and adults (from 18 years old). The repeat survey sent to Swedish participants addressed mainly socio-demographic characteristics, well-being, media use, physical activity, sleep behaviours, alcohol consumption, dietary behaviour, and a series of food frequency questions.

The 2020 examination was completed in all participating countries but with varied success and data collection time frames due to interruptions related to the COVID-19 restrictions. Sweden started on time, had no postal or staff disruptions, and collected information from 819 participants in the pre-pandemic period. First, participants received a phone call invitation following a standard protocol developed at the coordinating centre in Bremen, Germany, and they could choose to answer the questionnaires either online or by paper. In 2020, the response rate in Sweden was 44%. For the 2021 survey, which was a local investigation, 415 participants from the pre-COVID-19 examination were reinvited to complete a shorter version of the questionnaire focused on diet, well-being, and lifestyle measures. All surveys were distributed as a paper form and sent by postal mail with a self-addressed return envelope. A response rate of 48% was achieved (**Figure 2**). In the first examination, approximately 92% of the participants submitted their questionnaires in the fall, between September 2020 and December 2020. The mean span between responses in 2020 and 2021 was 251, ranging from 152 to 471 days.

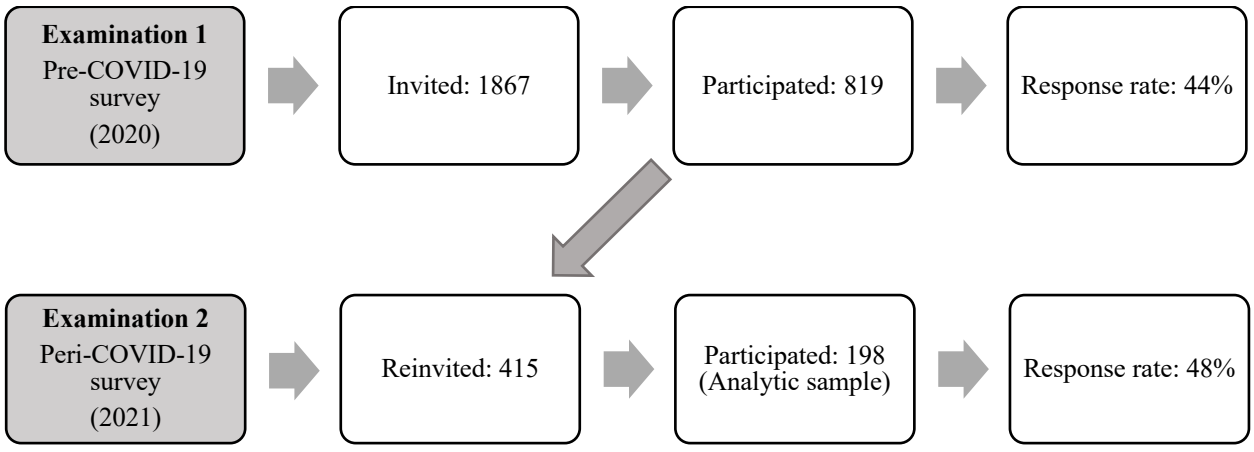

Figure 2: Number of participants and response rates in the pre-pandemic examination (2020) and peri-pandemic examination (2021) of the I.Family study.

Data management methods

Data management was handled by the coordinating centre in Bremen, Germany, at the Leibniz Institute for Prevention Research and Epidemiology – BIPS / GmbH – Division Biometry and Data management. The dataset for the analysis in this thesis was prepared by myself with the help of my supervisor. First, the two waves were merged by participant study identification numbers to have both observation time points in a single dataset, and hence have paired observations ready for analysis. In the earliest stages, I worked on the data cleaning and discovered issues related to sex and birthdate "changes". After investigating these implausible values, we found households in which siblings had both participated and had switched questionnaires. After identifying these errors, we pulled the original questionnaires, reported the errors to the data coordinating centre, and built a new dataset that contained the corrections. Subsequently, the descriptive statistics on well-being, physical activity, sleep patterns, screen time, dietary behaviour, and food consumption were inspected.

The exposure variable was defined as the COVID-19 pandemic and the Swedish government's response to the pandemic. The dependent variables were physical activity, sleep pattern, screen time, well-being, and diet-related outcomes. The variables age, sex, educational status and living arrangements were background variables used to describe the population. In addition, the height and weight were used to calculate the BMI, and its classification for those aged 18 years and older was done according to WHO (2000), while for those who were younger than 18 years it was according to Cole & Lobstein (2012). The KINDL well-being score was used to assess well-being in participants younger than 18 years, which is the cut-off age for using the tool. The tool includes questions about feelings and social activities and the score ranges from 0 to 100, where higher scores indicate better well-being (Ravens-Sieberer, & Bullinger, 1998).

Information on screen time was collected using a series of questions that had six response alternatives containing time ranges, which refer to the time of screen exposure during weekdays and weekends. To assess physical activity, participants were asked to inform the number of hours and minutes spent in school sports and sports club or gym. Sleep habits were measured in hours and minutes slept during weekdays and weekends, considering both nocturnal sleep and naps. The variables concerning physical activity, screen time, and sleep patterns were analysed as continuous variables (in hours per day and hours per week).

Data on dietary behaviours were collected using a 5-point Likert scale. In addition, the consumption of alcoholic beverages was assessed in relation to the number of drinks the respondents had when they drank alcoholic beverages in the previous year, where a drink unit was exemplified as a glass of wine, a bottle or can of beer, or a double shot of spirits. Furthermore, there was a detailed food frequency questionnaire, referring to the month before completing the survey, where the respondents had to choose between seven response alternatives to report the frequency of consumption of selected food and beverage items. The food frequency categories were used by the statistical team to perform calculations of continuous variables that account for the frequency of consumption (times/day and times/week) of specific food groups, and to calculate some food-related scores, including the sweet propensity score, which reflects the proportion of sweet foods in the whole diet (including diet soft drinks), the sugar propensity score, which is calculated as the ratio of frequencies of sugar-rich items consumed to total food items, and the Healthy Diet Score (HDS), a score that encompasses five sub-scores reflecting adherence to nutrition guidelines on consumption of fruit and vegetables, fish, whole grains, fat, and sugar (Arvidsson et al., 2016, 2017; Jilani et al., 2019).

Analytical approach

Statistical analyses were performed using Stata version 17.0 statistical software package (StataCorp, Texas, USA). Quantitative variables were presented as mean and standard deviation (SD) and categorical variables were presented using absolute frequencies and percentages. To compare the pre-pandemic and peri-pandemic periods, the paired observations were analysed using the paired t-test to determine if there was a difference between continuous variables, with a confidence interval (CI) of 95%. The Wilcoxon matched-pairs signed-rank test was used to compare differences among the categorical variables. Significance levels were set at $p < 0.05$ for all statistical analyses. In addition, the direction of change (increased/unchanged/reduced) of dietary behaviours and food consumption of selected food and beverage items were calculated and presented as percentages. Stratified analyses by sex, age category (<18 years old and ≥ 18 years old), and school-age category (<16 years old and ≥16 years old) were also performed. The school-age category represents those that were receiving in-class education (<16 years old), and those that were either taking online classes or were no longer studying (≥16 years old).

Ethical Considerations

The IDEFICS and I.Family studies acceded to the Declaration of Helsinki of ethical principles for research that includes human subjects. In order to participate, written informed consent was required from parents and children from the age of 12 years onwards, while verbal assent was also required from younger children. Each participating country received ethical approval from the suitable local ethics board. In Sweden, the approval was conceded by the Regional Ethics Research Board in Gothenburg, 30/Jul/2007, ref: No. 264-07 and 10/Jan/2013, No. 927-12. Additionally, general data protection rules (GDPR) have been followed and the data has been stored on a secure server with password encryption.

Importantly, additional considerations and reflections may be needed when the research subjects include children and adolescents, who are deemed as potentially vulnerable populations, and therefore must be protected (Jacobsen, 2017). In this regard, it is considered that be a subject in IDEFICS/I.Family studies involve minimal to no risks. Although for some children and adolescents, questions about lifestyle and well-being could be perceived as sensitive, the nature of the questions does not pose a serious risk. Nevertheless, the potential benefits and risks of participating were explained, and the participants were free to contact the principal investigator in case of a complaint. Besides, there are no conflicts of interest involved in any phase of the research.

According to Jacobsen (2017), the central underlying foundations of biomedical research ethics such as beneficence, respect, and justice, should cover the entire research process, including data analysis and communication of the findings. In this sense, compliance with the principles underpinning ethical practice when accessing data and accomplishing further research steps is pivotal. Additionally, to ensure credibility, it is imperative to recognise and disclose study limitations and the possibility of bias (Walliman, 2018).

Results

Participants' characteristics

The study sample consisted of 198 participants, 59% females. At the first measurement, the respondents' mean age (SD) was 17.6 (2.12) years, ranging from 12 to 21.7 years. **Table 1** shows the characteristics of the participants stratified by underage (<18 years) and adulthood (≥ 18 years) at the first measurement in 2020, where just over half were underage (57%). Among those younger than 18 years old, 81% were classified as normal weight, while for those older than 18 years, 75% fall into the normal weight category. About half of the respondents younger than 18 years old (54%) were attending secondary school or technical school, while 43% were attending the gymnasium (upper secondary school). Among those aged 18 years or older, 42% were no longer students, 33% were attending the gymnasium, and 25% were attending university. Most of the individuals in both age categories lived with their parents (97% among those younger than 18 years old, and 80% among those aged 18 years or older).

Table 1. Characteristics of participants (n = 198) stratified by age at the examination in 2020.

Variables	**< 18 years** (n = 113)	**≥ 18 years** (n = 85)
Sex	**n (%)**	**n (%)**
Male	53 (47)	29 (34)
Female	60 (53)	56 (66)
BMI categories	**n (%)** [a]	**n (%)** [b]
Underweight	11 (10)	5 (6)
Normal weight	88 (81)	63 (75)
Overweight	9 (8)	14 (17)
Obese	1 (1)	2 (2)
Educational status	**n (%)**	**n (%)** [b]
Pre-gymnasium	61 (54)	-
Gymnasium	49 (43)	28 (33)
University / College	-	21 (25)
No longer a student	3 (3)	35 (42)
Living arrangement	**n (%)**	**n (%)**
Living with parent(s)	110 (97)	68 (80)
Other	3 (3)	17 (20)

[a] Four missing values. [b] One missing value.

Lifestyle habits and BMI

Table 2 shows the lifestyle habits and BMI of the participants before and during the COVID-19 pandemic. There was a significant decrease in physical activity, specifically in the weekly hours spent doing sports in sports clubs or gyms (5.37 hours to 4.79 hours). Stratified analysis (not displayed in the table) by sex and school-age categories showed that the decrease was significant among girls and equally significant in both age groups. Sleep duration increased significantly during the COVID-19 pandemic, considering both nocturnal sleep (8.02 hours to 8.15 hours) and total sleep (8.23 hours to 8.41 hours). Stratified analysis by sex showed no difference in sleep duration between males and females, while the stratified analysis by school-age categories showed that the increase was significant only among those aged 16 years or older (n = 146). Time spent with audio-visual media, considering weekdays as well as the whole week, did not change significantly. During the two measurement periods, it was observed a small increase in the participant's mean BMI, from 21.45 Kg/m^2 to 21.63 Kg/m^2. Stratified analyses of BMI showed that the difference was driven by the boys, younger than 18 years old.

Well-being

The KINDL well-being score and a sampling of relevant questions included in the screener are depicted in **Table 3**. Comparing the pre-pandemic and the peri-pandemic periods, the KINDL score decreased significantly. When assessing the score closely, in the question *During the past week I had fun and laughed a lot*, there was a significant decrease in the percentage of individuals that answered *often* (73% to 60%) and *all the time* (5% to 3%). Additionally, the proportion of those that affirmed to have felt alone in the previous week significantly increased (*sometimes:* 13% to 22%, *often* 4% to 6%, and *all the time* 0 to 2%). Moreover, the proportion of participants that did things together with their friends *often* decreased (47% to 27%), while those that referred that doing schoolwork was easy *all the time* also reduced (35% to 26%). No significant changes were observed in the questions concerning boredom and worry about the future.

Table 2. Lifestyle and BMI of participants before and during the COVID-19 pandemic.

Lifestyle habits	**n obs** [a]	**Before COVID -19** Mean (SD)	**During COVID-19** Mean (SD)	**p-value** [b]
Physical activity				
Total time (in hours) involved in school sports during a typical school week	114	3.02 (2.01)	3.22 (2.90)	0.4923
Total time (in hours) spent doing sports per week in sports club or gym	163	5.37 (3.54)	4.79 (3.57)	**0.0054**
Sleep pattern				
Nocturnal sleep (hours/night on weekdays and weekends)	196	8.02 (0.86)	8.15 (0.83)	**0.0129**
Total sleep (Nocturnal sleep and napping time on weekdays and weekends)	196	8.23 (0.90)	8.41 (1.08)	**0.0152**
Screen time				
Time (in hours) spent with audio-visual media (TV + web + PC) on weekdays	157	3.33 (2.67)	3.39 (2.73)	0.7456
Time (in hours) spent with audio-visual media (TV + web + PC) during the whole week	154	18.84 (11.22)	18.90 (12.03)	0.9546
BMI (Kg/m^2)	190	21.45 (3.07)	21.63 (3.09)	**0.0093**

[a] Number of observations. [b] T-test for paired data. Significant measures are shown in bold.

Table 3. Well-being among participants aged 12 – 17 years old (n = 106) before and during the COVID-19 pandemic.

Indicators		Before COVID -19	During COVID-19	p-value [c,d]
KINDL well-being score [a,b]		69.32 (12.19)	67.21 (12.72)	**0.0284** [c]
		n (%)	**n (%)**	
During the past week I had fun and laughed a lot	Never	-	-	**0.0025** [d]
	Seldom	2 (2%)	7 (7%)	
	Sometimes	21 (20%)	32 (30%)	
	Often	77 (73%)	64 (60%)	
	All the time	6 (5%)	3 (3%)	
During the past week I was bored	Never	6 (6%)	8 (7%)	0.6346 [d]
	Seldom	49 (46%)	38 (36%)	
	Sometimes	35 (33%)	39 (37%)	
	Often	13 (12%)	21 (20%)	
	All the time	3 (3%)	-	
During the past week I felt alone	Never	53 (50%)	42 (40%)	**0.0026** [d]
	Seldom	35 (33%)	32 (30%)	
	Sometimes	14 (13%)	23 (22%)	
	Often	4 (4%)	7 (6%)	
	All the time	-	2 (2%)	
During the past week I did things together with my friends [e]	Never	4 (4%)	13 (13%)	**0.0003** [d]
	Seldom	12 (12%)	22 (21%)	
	Sometimes	31 (30%)	33 (32%)	
	Often	49 (47%)	28 (27%)	
	All the time	7 (7%)	7 (7%)	
During the last week in which I was at school doing schoolwork was easy [f]	Never	2 (2%)	1 (1%)	**0.0133** [d]
	Seldom	3 (3%)	7 (7%)	
	Sometimes	12 (12%)	18 (18%)	
	Often	49 (48%)	49 (48%)	
	All the time	36 (35%)	27 (26%)	
During the last week in which I was at school I was worried about my future [f]	Never	30 (29%)	23 (23%)	0.1062 [d]
	Seldom	41 (40%)	37 (36%)	
	Sometimes	17 (17%)	29 (28%)	
	Often	11 (11%)	7 (7%)	
	All the time	3 (3%)	6 (6%)	

[a] Values presented as mean (SD). [b] Seven missing values. [c] T-test for paired data. [d] Wilcoxon matched-pairs signed-rank test. [e] Three missing values. [f] Four missing values. Significant measures are shown in bold.

Dietary behaviour and food frequency

When analysing the pattern of meal consumption in the pre-pandemic and the peri-pandemic periods, it was observed a significant reduction in the proportion of individuals that ate breakfast daily (73% to 68%). Stratified analyses showed that the decrease was significant only among boys, aged 16 years or older. In contrast, no significant changes were observed in the other daily meals. Another eating behaviour that changed significantly among the respondents was eating lunch with others. There was a significant increase in the proportion of individuals that ate lunch with a partner or other family member (6% to 18%), while the proportion of individuals that ate lunch with friends or colleagues decreased (81% to 45%).

The changes in the frequency of consumption of selected food and beverage groups, in addition to specific food-related scores, are depicted in **Table 4**. There was a significant reduction in both daily (3.15 to 2.74) and weekly (22.08 to 19.16) frequency of fruits and vegetables consumption. Similarly, a significant decrease in the daily frequency of consumption of fibre rich food (4.27 to 3.75) was observed. The weekly frequency of consumption of artificially sweetened drinks significantly reduced (2.78 to 2.05), as well as the sweet propensity score (15.99 to 14.92). Moreover, there was a significant decrease in the number of drinks the respondents had when they drank alcoholic beverages (4.25 to 3.70). No significant changes were observed in the frequency of consumption of dairy products, fish, red meat, preserved food, carbonated drinks, junk food, and fatty food. Similarly, there was no significant change in the sugar propensity score and the HDS. Stratified analysis (not displayed in the table) by sex and school-age category showed significant differences only regarding fruits and vegetables frequency (times/day and times/week), where the decrease in consumption was significant among boys, younger than 16 years old.

Table 4. Dietary behaviour of participants before and during the COVID-19 pandemic.

Food groups	n obs [a]	Before COVID -19 Mean (SD)	During COVID-19 Mean (SD)	p-value [b]
Fruits and vegetables frequency (times/day)	188	3.15 (1.94)	2.74 (1.56)	**0.0014**
Fruits and vegetables frequency (times/week)	188	22.08 (13.60)	19.16 (10.97)	**0.0014**
Dairy products (times/day)	177	3.10 (1.82)	3.18 (2.12)	0.4506
Fish frequency (times/week)	188	3.27 (1.37)	3.40 (1.76)	0.2295
Red meat frequency (times/week)	187	7.35 (5.54)	7.60 (6.43)	0.5159
Fibre rich food frequency (times/day)	177	4.27 (2.39)	3.75 (1.99)	**0.0005**
Preserved food (times/week)	186	3.55 (3.74)	3.64 (4.12)	0.7087
Carbonated drinks (times/week)	190	3.40 (4.89)	3.09 (4.68)	0.2783
Junk food frequency (times/day)	189	1.19 (0.78)	1.14 (0.79)	0.3103
Junk food frequency (times/week)	189	8.34 (5.47)	7.98 (5.58)	0.3091
Fatty food frequency (times/day)	180	1.08 (0.57)	1.14 (0.73)	0.3371
Artificially sweetened drinks (times/week)	187	2.78 (6.25)	2.05 (3.88)	**0.0276**
Sweet propensity score (including diet soft drinks)	193	15.99 (9.28)	14.92 (8.13)	**0.0260**
Sugar propensity score (excluding diet soft drinks)	193	13.85 (7.34)	13.22 (7.38)	0.1732
Healthy diet score (HDS)	193	25.26 (7.14)	25.88 (7.07)	0.1766
Number of drinks when drinking alcoholic beverages	94	4.25 (2.47)	3.70 (2.33)	**0.0384**

[a] Number of observations. [b] T-test for paired data. Significant measures are shown in bold.

The direction of changes in the frequency of consumption of selected food and beverage items along with some selected dietary behaviours are provided in **Figure 3**. More than a third of the participants reduced their consumption of raw vegetables and a fifth reduced their consumption of legumes. Additionally, 29% of the participants increased their consumption of processed meat, 14% increased their frequency of eating pizza as a main dish, and 15% reduced the frequency of eating breakfast daily. A reduction in the consumption of sugary drinks, carbonated sugary drinks, and artificially sweetened drinks was observed among 23%, 19%, and 17% of the participants, respectively. Furthermore, 34% of the respondents decreased the frequency of eating out meals such as takeaway or fast food.

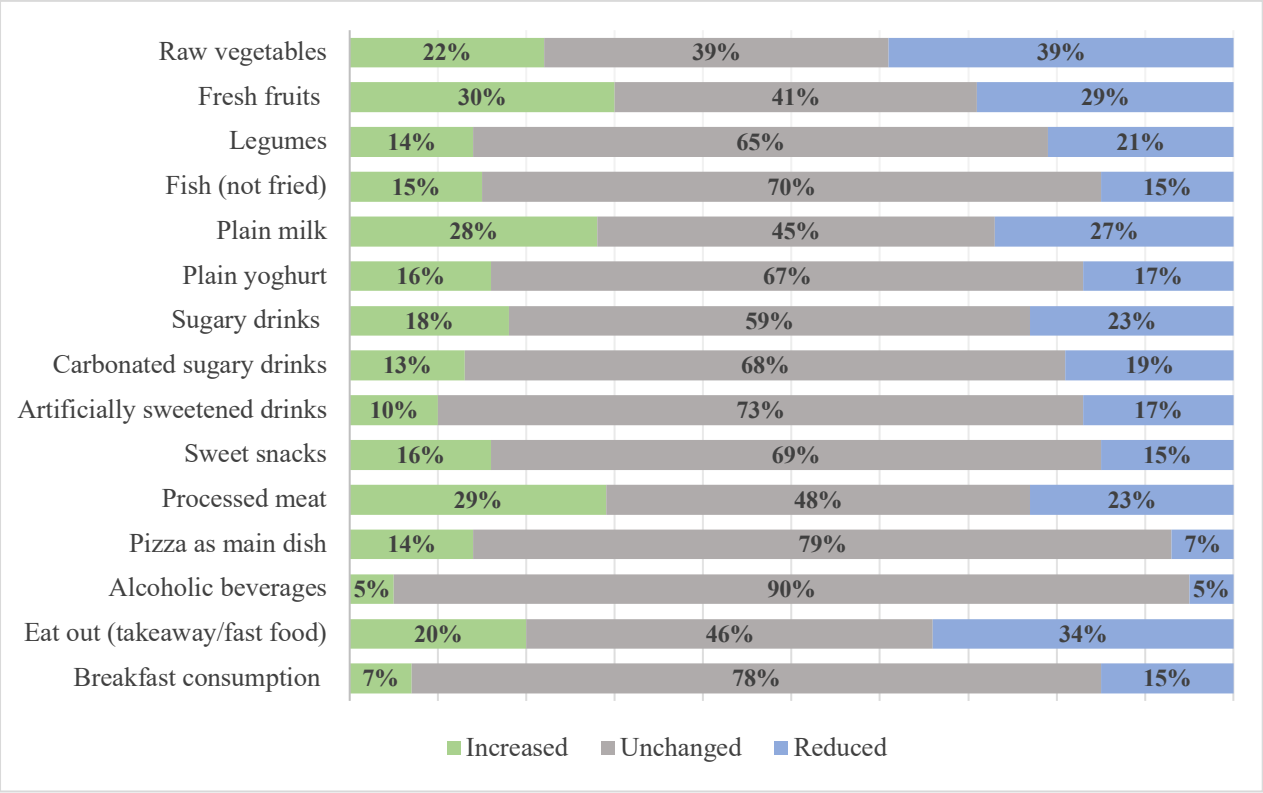

Figure 3. Variations in dietary intake and behaviour changes of all participants during the COVID-19 pandemic.

Discussion

The present study provides novel data on the impacts of the COVID-19 pandemic on a range of diet, lifestyle, and well-being outcomes among young Swedes, suggesting that changes in structures and norms across societal levels have influenced participants' behaviours, well-being, and dietary patterns. One of the main findings indicates that, when comparing the pre-pandemic and the peri-pandemic periods, there was a decrease in physical activity levels related to the time spent in the sports club or gym. The observed reduction of 0.58 hours/week (35 minutes/week) of physical activity is lower than the difference found by López-Bueno et al. (2020), who reported a reduction of 1.40 hours/week in physical activity among Spanish children and adolescents. A substantial decrease in the average time spent in physical activity was also reported by Xiang et al. (2020), with a difference of 435 minutes/week (7.25 hours/week), among Chinese children. Differences between the results might be due to the stricter containment measures adopted by Spain and China compared to Sweden, which included home confinement and closure of schools. Even though the observed difference of 35 minutes/week might be considered a minor reduction, it is still deemed as a negative change, given that it contributes to the increase in sedentary behaviours and the low prevalence of adequate physical activity levels among the Swedish population. Possible explanations for our findings might be related to the shutdown of sports facilities for a few weeks in Sweden, in addition to the fear of engaging in group activities and sharing equipment or using common areas during the periods of the spike of COVID-19 cases. Additional individual factors that might be included among the possible explanations are motivation, loneliness, social withdrawal, and altered sleep practices (Rahman & Chandrasekaran, 2021).

No changes in physical activity levels related to school sports were observed in the current study, which might be attributed to the fact that Sweden has kept the schools for children younger than 16 years old open throughout the course of the pandemic. Besides, an important finding observed in the stratified analyses was the significant reduction in physical activity among girls, which is consistent with findings from Moitra & Madan, (2022), in a study with Indian adolescents, where was observed a lower frequency of being active among girls compared to boys, during the peri-pandemic period. These results are likely to be related to global trends of physical activity participation, where girls are more physically inactive than boys since 85% of the girls do not meet the WHO recommendations for physical activity compared to 78% of the boys (Duffey et al., 2021).

Increased sleep duration was observed in the present study. In line with this finding, Medrano et al. (2021) found that Spanish children increased sleeping time on both week and weekend days. Similarly, Gruber et al. (2021) reported longer sleep duration among adolescents in a longitudinal study conducted in Canada. Moreover, a significant increment in sleep time among Italian children was also reported by Pietrobelli et al., (2020), however to a larger extent (0.65 hours/day) than the difference found in our investigation (0.18 hours/day or 10 minutes/day in total sleep). Stratified analyses showed that the increase in sleep time was significant only among those aged 16 years or older in this study. This age group falls in the category of students that received online education in Sweden. It may be that these participants had less-structured routines and more sleep opportunities. This result is in agreement with those of Meltzer et al., (2021), that evaluated COVID-19 instructional approaches (in-person, online, hybrid) and sleep in U.S. adolescents, and showed that a less-scheduled approach provides more sleep opportunities. Similarly, Stone et al. (2021) found that remote teaching allowed the suppression of the morning commute, which was likely to enable a longer sleep time among Australian adolescents. Caution must be applied when qualifying our observed increased sleep duration as a positive or negative finding because the difference was small, and we have not assessed the quality of the sleep nor the reason for the increase. However, it could be considered an unfavourable change if it was related to poor sleep quality, inconsistent sleep patterns, increased sedentary behaviours, and a higher frequency of skipping breakfast. In addition, for those that have transitioned to online education during the COVID-19 pandemic and had a higher sleep time, it might be challenging to restore their sleep routines when returning to normalcy (Kharel et al., 2022).

During the peri-pandemic period, no changes in screen time were observed among the participants of the present study. This finding is contrary to previous studies that have suggested an increase in daily hours of screen exposure, such as the longitudinal investigations conducted by Munasinghe et al. (2020) in Australia, Pietrobelli et al., (2020), in Italy, and Schmidt et al. (2020), in Germany. Besides, cross-sectional studies conducted among children in India (Moitra & Madan, 2022), Croatia (Kenđel Jovanović et al., 2021), and the U.S. (Nagata et al., 2022) have yielded similar results, demonstrating an increase in screen time. In most studies, distance learning and stringent containment measures were suggested as the explanations for the excessive screen time. Therefore, the discrepancy in the results between Sweden and the other countries which have reported findings could be attributed to the different contextual factors such as the face-to-face education that has prevailed in Sweden for children

younger than 16 years old, and to the less stringent policy restrictions adopted by the Swedish government. In addition, distance learning is a habitual component of the Swedish educational system, especially in higher education, where online classes have been available before the pandemic. Hence, remote education does not seem to have contributed to increasing screen time.

An increase in BMI was observed in this study, which appeared to be most pronounced among younger boys. However, due to a lack of power, it was not possible to proceed with more stratified analyses. Similar findings were identified by Jia et al. (2021), among youth in China, where the increment in BMI was higher among high school students compared to graduate students. In the same study, considering only the sample of high school students, the increase in BMI was also higher in boys than girls. The observed difference in BMI in our total sample was 0.18 Kg/m^2, which is smaller than the value of 0.3 Kg/m^2 found by Jia et al. (2021). The BMI increase among younger boys in our study was found to be 0.45 Kg/m^2, which was also smaller than the difference of 1.1 Kg/m^2 reported by Jia et al. (2021). These differences may be explained by the circumstances of the social distancing measures, where China imposed a strict lockdown on its population, which might have implied an increase in sedentary behaviours and consequent weight gain. A significant increase in BMI during the COVID-19 pandemic among schoolchildren was also reported by Kenđel Jovanović et al. (2021), however to a larger extent (0.66 Kg/m^2), and with a similar variation in boys and girls. Increment in BMI during the peri-pandemic period among children and adolescents was also observed in Turkey (Durmuş & Solak, 2021), Jordan (Al Hourani et al., 2021), and the U.S. (Woolford et al., 2021).

Our results, however, must be interpreted with caution because the found difference was small and the anthropometric data were self-reported. Although the value was statistically significant, it might be argued that there is no practical significance, since an increase in body weight in this age group may be due to the natural growth trend and maturation. Moreover, no interaction was observed between BMI, age, and sex, and no dramatic changes in height and weight were found. Further, we did not observe unhealthy BMI ranges, confirmed by the fact that 84% of the participants were in the normal weight category at both time points. Nevertheless, from a life course perspective, if an increasing trend in BMI were to be sustained during adolescence, this could represent a risk factor for NCDs at a later stage in life (Akseer et al., 2020).

Lower levels of well-being were reported by the participants during the peri-pandemic period, according to the KINDL well-being score. The average score of the participants during the COVID-19 pandemic was found to be 67.21, which is lower than the value of 73.91, reported Adıbelli & Sümen (2020), in Turkish children. Diminished well-being levels observed in this study corroborate the findings of Morres et al. (2021), who showed low levels of well-being among Greek adolescents, using a different score. Poor well-being among adolescents has also been identified in Australia by Li et al. (2021), who also reported psychological distress and health anxiety. Furthermore, in accordance with the present investigation, Croatian schoolchildren surveyed by Kenđel Jovanović et al. (2021) reported loneliness and the feeling of not being successful in their learning, while adolescents in Australia reported loneliness and a decline in happiness (Munasinghe et al., 2020). In Sweden, using a survey with open-ended questions, Sarkadi et al. (2021) reported high levels of worry among children and adolescents, including worry about disease and death, and the future. This result differs from our findings, where no significant changes were observed in worry about the future, and the decrease in happiness and the increase in loneliness appeared to be the most relevant negative feelings among the participants.

Studies conducted among Swedish adult populations have shown different impacts on well-being dimensions. Tishelman et al. (2021) found that the most feared aspects concerning the COVID-19 pandemic rest on a societal level. In addition, Blom et al. (2021) showed that, among a range of mental health experiences, the more prevalent was the health anxiety for relatives. Moreover, Brogårdh et al. (2021) assessed self-perceived life satisfaction and reported that, while 97% of the participants were satisfied with the ability to manage daily activities, only 43% were satisfied with contact with friends. Given that family and peer relations are included among the social determinants of health and can influence health behaviours, it can thus be argued that similar findings might also be true for young Swedes.

Most of the found studies have indicated social isolation and the uncertainty around the health and economic crises as the main risk factors for poorer psychological well-being during the COVID-19 pandemic, with a potential impact on young people. Even though Sweden has taken more lenient measures that allowed relative freedom of movement, the death toll has been higher, chiefly among the elderly, when compared to other Scandinavian countries. Additionally, impacts at the country level, such as the economic downturn and its consequences on the labour market, might have caused financial distress for many families. Besides, the pandemic has given rise to unusual societal circumstances, where, for many, the regular reports

on mortality and the constant emphasis on preventive measures may have caused fear, anxiety, and distress. Therefore, it is likely that the young Swedes have experienced reduced social activities and social connections, especially involving older relatives, alongside changes in daily routines, and an array of negative feelings. Another aspect to be considered is the relationship between physical activity and well-being. Studies in adults and adolescents have demonstrated that adequate and regular physical activity has had an association with improvement of overall well-being outcomes during the COVID-19 pandemic (Abdelbasset et al., 2021; Wright et al., 2021). This is of special importance among young people, as childhood is the period where most mental health disorders initiate, and a public health emergency with enormous societal repercussions such as the COVID-19 pandemic is likely to compound the problem and engender long-term repercussions (Golberstein et al., 2020).

Several studies on the COVID-19 pandemic have shown that the alterations in daily life have changed eating conditions and dietary behaviours. In our sample, it was observed a reduction in the proportion of individuals that ate breakfast daily, notably among older boys. Similar behaviour was observed among Indian adolescents (Moitra & Madan, 2022). In contrast, Chilean children and adolescents showed high compliance with the recommendation of eating breakfast daily, with a higher proportion among those aged 2-10 years old compared to adolescents (Bustos-Arriagada et al., 2021). A possible explanation for our results may be related to the fact that the older group received online education and had higher sleep duration, which might represent a less structured routine. Additionally, females seem to be more conscious about healthy eating and body shape and are more likely to make healthy food choices, which has been demonstrated in studies in adult populations in Sweden (Bärebring et al., 2020) and elsewhere (Wardle et al., 2004). Eating a healthy breakfast daily is a habit that should be promoted during childhood and adolescence, as it has been associated with a higher intake of key nutrients, alongside positive effects on metabolic outcomes, academic achievement, and quality of life (Lundqvist et al., 2019; Moreno Aznar et al., 2021).

Our findings showed that the COVID-19 pandemic has changed the food environment, with an increment in the proportion of individuals that ate lunch with a partner or other family member, and a decrease in the proportion of those that ate lunch with friends or colleagues. In addition, there was a decrease in the frequency of eating out. This could be considered as another example of how infection control measures have directly affected individuals' behaviours. Even though the Swedish government has not enforced strict home confinement and the closure of restaurants, the implementation of remote learning and working, and the fear

of contracting and spreading the virus while eating out might be possible explanations for our findings. Admittedly, these changes in eating habits could be deemed as positive if they have somehow contributed to improving family connection and communication and increased the consumption of home-cooked meals.

A relevant finding in this study was the reduction in the frequency of consumption of fruits and vegetables, which is possibly connected to another finding, the reduction in the frequency of consumption of fibre rich food. Previous research has shown varied results on the effects of the COVID-19 pandemic on the consumption of fruits and vegetables, which might be attributed to contextual factors and the degree of restrictions. Similar to our study, López-Bueno et al. (2020) reported a reduction in fruit and vegetable consumption in Spain. Differently, Yu et al. (2021) identified an increase in fruit and vegetable intake among Chinese youth. Diverse results were reported by Pietrobelli et al. (2020), with an increase in fruit intake and no changes in vegetable intake in Italy, and Malta et al. (2021), who observed an increase in vegetable intake and no changes in fruit intake among Brazilian adolescents. Stratified analysis showed that the decrease in the consumption of fruits and vegetables in our study was significant among boys, younger than 16 years old, which may partly be explained by the fact that some Swedish schools removed or reduced salad buffets (Ala-Karvia et al., 2022). These results are rather disappointing, since fruits and vegetables are important sources of vitamins, minerals, antioxidants, and fibre, and are connected to a myriad of health benefits. Moreover, they are essential components of a healthy diet in all age groups but should be emphasised particularly among young people due to the high nutritional demands related to physiological growth, and because childhood and adolescence are periods where eating habits are shaped.

Also included among the negative findings, 29% of the participants increased their consumption of processed meat and 14% increased their frequency of eating pizza as a main dish. A similar trend was observed in a sample of young Italians, where 47% reported increased consumption of pizza, and 23% increased the consumption of processed meats (Mazza et al., 2021). These results are not encouraging, because depending on the nature and extent of food processing, certain kinds of cold cuts and ready-to-heat pizzas may be classified as ultra-processed foods, which are industrial formulations with poor nutritional quality, usually energy-dense and rich in unhealthy sort of fats. High consumption of this category of food has been associated with NCDs and negative environmental impacts (Monteiro et al., 2018). Contrary to previous studies which have found significant variation in the consumption of snacks and junk foods during the peri-pandemic period (Al Hourani et al., 2021; Androutsos et

al., 2021; Pietrobelli et al., 2020), no difference in the consumption of these kinds of food was observed in our sample.

Positive changes associated with healthier eating habits identified in our study were the reduction of the frequency of consumption of artificially sweetened drinks and the reduction of the sweet propensity score. Besides, almost a quarter of the participants reduced their consumption of sugary drinks. Identified studies that reported variation in the consumption of sweet beverages during the COVID-19 pandemic did not segregate those artificially sweetened, therefore it is difficult to compare the findings. However, as the sweet propensity score encompasses all sweet foods consumed, it is possible to make some comparisons. For instance, Aguilar-Martínez et al. (2021) reported that the consumption of soft drinks decreased by 49.8% among Spanish adolescents. In contrast, the study by Androutsos et al. (2021) indicated an increase in the consumption of sweets among Greek children and adolescents. Furthermore, Ruiz-Roso et al. (2020) reported a higher sweet consumption in a multinational investigation of adolescents. Possible explanations for our findings might be the reduced frequencies of eating out and of having meals with friends and colleagues, as it has been described that the consumption of sweet foods is associated with peers' consumption (Robinson et al., 2016).

Still, another positive finding was the decrease in the consumption of alcoholic beverages in the peri-pandemic period. In line with our findings, Hviid et al. (2022) reported a reduction in alcohol consumption among adolescents in Denmark during the country's first lockdown. A decrease in alcohol consumption was also identified among adolescents in Brazil (Malta et al., 2021). In contrast, Kapetanovic et al. (2022) showed an increased substance use, including alcohol, among Swedish youth with strained family relations and that reported difficulty to comply with government recommendations. Furthermore, mixed results were observed in studies among young adults. In the U.S., an increase in alcohol consumption was reported by Lechner et al. (2020), while studies conducted in Belgium (Bollen et al., 2021) and the UK (Evans et al., 2021) identified a reduction in alcohol use. Our findings might be explained by the change in the food environment, with reduced frequency of eating out and having lunch with friends, and by the temporary ban of alcohol sales in restaurants from a certain time enforced in Sweden during the COVID-19 pandemic. However, these explanations are speculative and would need to be explored in future studies.

Strengths and limitations

The present study has been one of the first attempts to provide a comprehensive assessment of changes in diet, lifestyle, and well-being among young Swedes during the COVID-19 pandemic. The main strengths rest in its longitudinal design and timely data collection in the pre-and peri-pandemic periods. On the other hand, the self-reported data might be a potential limitation because it can be related to recall bias and some missing or misreporting of data. Additionally, reports on health and dietary behaviours may be subject to social desirability bias. Nevertheless, self-reported questionnaires were commonly employed in similar studies conducted during the pandemic, although in many cases they lack repeated measures. Voluntary participation, difficulties to reach participants, and an insufficient sample size might be additional biases. Moreover, the sample is not representative of all young people living in the Västra Götaland County, as the participants were residing predominantly in affluent areas. Furthermore, the reported changes were assessed in a short interval, thus it cannot be inferred their duration for the long term. Last, the observational design of the study does not allow us to establish any causal relationship.

Conclusions and Implications for Future Research

The results of this investigation have suggested changes in lifestyle, dietary behaviours, and well-being among young Swedes during the peri-pandemic period. Mostly unfavourable, these changes include reduced physical activity, lower levels of well-being, a decline in the consumption of fruits and vegetables, and a reduction in the proportion of individuals that ate breakfast daily. However, some positive changes were also observed in that the sweet propensity score reduced, and the consumption of artificially sweetened beverages and alcohol diminished. Furthermore, this study identified an increased sleep duration and changes in the food environment, including a lower frequency of eating out, fewer individuals having lunch with a friend or colleague, and a higher proportion of individuals having lunch with a partner or other family member. These changes are more difficult to qualify as positive or negative.

Notwithstanding its limitations, this study offers valuable insights into the impact of a unique mitigation strategy on young people. Undoubtedly, these results add to the growing body of evidence that indicates relevant, diverse, and mostly negative behavioural changes during the COVID-19 pandemic, globally. Further research could usefully explore the continuation of these changes and their potential long-term effects. Altogether, our findings

have relevant public health implications when it comes to informing policies aimed at supporting well-being and promoting a healthy lifestyle among this particular age group, especially following this social disruption period. In this regard, effective interventions are needed to avoid adverse health outcomes that include mental health disorders, obesity, and diet-related non-communicable diseases.

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