The Effect of Adolescents' Physical Activity Levels on Physical Health Outcomes

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Abstract

Participation in physical activity (PA) in adolescents is inversely related to normal growth, physical, and mental health. As evidence of the health benefits of PA grew, several institutions established PA policies. The goal of this study was to investigate the levels of physical activity in German adolescents and their effects on physical well-being, as well as to assess the socioeconomic correlates of adherence to PA guidelines. Limited research tries to combine these three aspects. Insights into the results can help the creation of physical activity policies for adolescents in Germany to reduce the number of people being unhealthy due to the lack of PA.

The study included 5,197 adolescents aged 11 to 17 who lived in Germany between 2003 and 2006. The variable 'KINDL – physical well-being' is used as the dependent variable because of the health-related quality of this variable. The main independent variables used to determine the relationship are PA levels and socioeconomic status (SES). Using multiple linear regression, the frequency of physical activity was found to be a significant predictor of physical well-being. The variables physical activity: hours/week and socioeconomic factors were not significant.

The majority of adolescents do not get the recommended 60 minutes of moderate to vigorous physical activity per day. The results showed that the effect on physical well-being is not that strong. Males participate more in PA compared to girls. Furthermore, older adolescents have a negative relationship with their physical well-being when compared to younger adolescents. Future research could include a longitudinal cohort study of children aged 3 to 17 years to see if their level of physical activity varies over time and how this may affect their physical well-being. Also, it would be interesting to combine other influential factors into the relationship with physical health.

Keywords: physical health, physical activity levels, socioeconomic status, adolescents

1. Introduction

1.1 Background

The prevalence of overweight and obesity in children and adolescents is rising. This is a major public health concern in industrialised countries. Participation in physical activity (PA) is inversely related to being overweight and obese (Jekauc et al., 2012). Physically active children have higher levels of cardiorespiratory fitness, muscular endurance, and skeletal health. There is a decreased risk of getting cardiovascular and chronic diseases, and active adolescents have reduced symptoms of anxiety and depression compared to inactive adolescents (Veitch et al., 2010; Loprinzi et al., 2012; Jekauc et al., 2012). Inadequate levels of PA during childhood may also result in the development of a sedentary lifestyle in adulthood (Jekauc et al., 2012). Over the past decades, growing evidence of the health benefits of PA and the health risks evolving from the lack of PA caused several public health organisations to establish PA guidelines (Jekauc et al., 2012). One of these organisations is the World Health Organization (WHO).

They established daily physical activity guidelines deemed necessary for improved health outcomes. Children aged 5 to 17 should engage in at least 60 minutes of moderate to vigorous physical activity per day (WHO, 2020). Most children and adolescents in industrialised countries do not engage in moderate-to-vigorous physical activities on a daily basis. In 2016, 81% of adolescents aged 11 to 17 did not meet the requirements. (WHO, 2020). In Germany, 83.1% of 11- to 17-year-olds did not meet these requirements (WHO, 2021).

Adolescents' physical well-being is influenced by their daily experiences of living and learning in their environment. The home environment influences the time spent on PA because leisure activities can either be at home or away from home (Jekauc et al., 2012). While WHO guidelines do not account for socioeconomic factors, research has shown that adolescents from lower socioeconomic status (SES) families are less physically active than adolescents from higher SES families (WHO, n.d.; Graf et al., 2014).

1.2 Research problem

Existing research has already established links between physical health and various levels of physical activity in adolescents. The relationship between migration, socioeconomic status, and physical health outcomes has also been studied. However, research on adolescent physical activity levels, physical health outcomes, and socioeconomic status falls short. As a result, this study will concentrate on the combination of those factors. Understanding how physical health changes with different levels of physical activity can help in the development of physical activity policies for adolescents, which can help to reduce the growing health concern. The KiGGS dataset, which contains information on German children aged 0 to 17, is central to this study. German children begin secondary school at the age of eleven. Adolescents aged 11 to 17 years self-assessed the questions in the KiGGS dataset rather than having their parents fill in the questions. Therefore, this study focuses on German adolescents aged 11 to 17.

1.3 Objective and research questions

This research aims to investigate the impact of different levels of physical activity on physical health outcomes in adolescents aged 11 to 17 years in Germany. To outline the effect of physical activity of adolescents on their physical health outcomes, this study revolves around the following sub-questions:

- What are the physical activity levels of adolescents in Germany at different ages?
- How does adolescents' physical health differ by different physical activity levels?
- What is the role of socioeconomic status in this relationship?

Together, the answers to these questions will answer the main research question:

What is the relationship between the level of physical activity of adolescents aged 11-17 years and physical health outcomes in Germany?

1.4 Structure of the thesis

This study is structured as follows: first, key concepts and theories related to physical activity, physical health outcomes, and socioeconomic factors will be discussed and explained using a conceptual model based on reviewed literature. Secondly, hypotheses for this research are composed. In the chapter Methodology, the context of the KiGGS dataset is then explained. It will be followed by explaining the key variables, and the process of data analysis. In chapter four the results of the performed tests are described followed by a chapter discussing the results and comparing them to the literature to answer the sub-questions. The study's strengths and weaknesses will be discussed as well. Finally, the research question will be addressed in chapter six by drawing conclusions from the results and discussion. Suggestions and recommendations for future research and policy implications are also addressed in the conclusion.

2. Theoretical Framework

2.1 Social cognitive theory

Literature suggests that there are several factors to keep in mind when determining adolescents' physical activity levels. One of these factors is the socioeconomic environment in which adolescents grow up. The Social Cognitive Theory explains how certain behaviours can change and how adolescents can be encouraged to exercise more. According to this theory, people are active agents who can influence and be influenced by their surroundings (Rhodos et al., 2019). Interventions in the social environment can encourage adolescents to engage in more physical activity. Individuals who are exposed to certain exercises are more likely to imitate and participate in them. The theory proposes that human behaviour is the result of a dynamic interaction between personal, behavioural, and environmental factors (Bagherniya et al., 2018).

Based on the literature, the conceptual model (Figure 1) suggests that physical health outcomes are impacted by the levels of physical activity and adolescents' socioeconomic background.

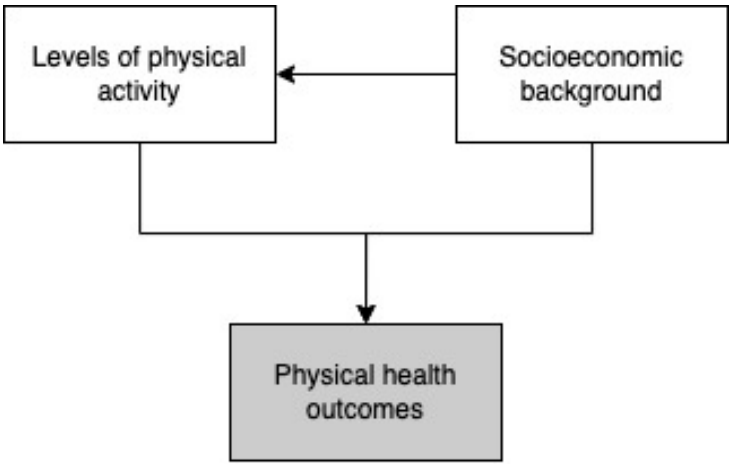

Figure 1: Conceptual model on the relationship between the level of physical activity and socioeconomic background on physical health outcomes (Author, 2022)

2.2 Physical activity

Any movement produced by skeletal muscle that uses energy is referred to as physical activity. Physical fitness, on the other hand, is a measurable state that includes things like strength and endurance. Physical activity that is planned to improve physical fitness and health is referred to as exercise (Obesity Medicine Association, 2020). Physical activity comes in different forms such as walking, cycling, sports and active forms of recreation. Adolescents differ from adults in that they attend school and do not have jobs where PA is required (WHO, 2018). One can think of the following physical activities for adolescents: playing outside (e.g., in the neighbourhood), sports in a club, participation in activities in school (e.g., physical education) or unregistered activity (e.g., spontaneous movement or short-term movement) (Kurth et al., 2008). According to Bar-Or and Baranowski (1994), lifestyle activities (such as walking to and from school) appear to have a longer-lasting impact than regimented activities (e.g., jogging). Therefore, it is also important to include lifestyle activities while registering adolescents' levels of PA.

The national recommendations in Germany on physical activity levels for children, adolescents, and adults are consistent with WHO recommendations. This means that adolescents should engage in activities that strengthen bones and muscles at least three times a week and engage in moderate- to vigorous-intensity physical activity for at least 60 minutes per day (WHO, n.d.; WHO, 2018). In Germany, physical education is mandatory across all *Länder,* but it can differ across the country due to differences in policies on a local level. Primary schools must provide 1.5 to 2.25 hours of physical education per week. For secondary schools, this lies between 2.25 and 3.75 hours per week. In addition, some schools have programmes and projects to encourage children to exercise (WHO, 2021). Aside from that, the German Olympic Sports Confederation organises initiatives to promote physical activity (Deutscher Olympischer Sportbund, n.d.).

The estimated prevalence of sufficient PA levels in adolescents is in Germany below the recommendations (WHO, 2021). Over the last decades, physical inactivity increased in adolescents (Stabelini et al., 2022). An increase in motorised traffic transporting adolescents to school or sports, and sedentary behaviour (e.g., TV watching, computer use, et cetera.) are reasons to explain this decline in energy expenditure (Biddle et al., 2004). Boys tend to engage more in physical activity compared to girls and the decrease in physical activity is also relatively higher in girls (Biddle et al., 2004; WHO, 2021).

2.3 Physical health outcomes

Physical activity and its effects on physical health are inversely related. There are major health consequences when adolescents do not engage in physical activity. Obesity rates and the prevalence of overweight children and adolescents are rising around the world (Biddle et al., 2004). Contributors to the rising prevalence of obesity are diets and exercise habits that have shifted over the last few decades (Hills et al., 2011). Obesity is associated with an increased risk of type II diabetes and dyslipidemia, both of which can lead to cardiovascular disease (Biddle et al., 2004; WHO, 2018). Due to sexual maturation and, in many cases, a reduction in

physical activity, puberty and the subsequent adolescent period are recognised as particularly vulnerable times for the development of obesity (Hills et al., 2011). Obese children are more physically inactive and have poorer motor skills than non-obese children (Hills et al., 2011). Obesity is already a health risk in childhood, but it is also a strong predictor of adult obesity (Biddle et al., 2004).

Encouraging youngsters to increase their levels of PA and decrease sedentary behaviour will help in the prevention of excess weight gain and health risks. One of the associated health risks to overweight and obesity is the development of cardiovascular disease (CVD). Development of CVD begins in childhood and adolescence, and, in most cases, it becomes evident later in life. Multiple factors contribute to the development of CVD. Nutrition has a major influence, but the level of PA can also be influential (Biddle et al., 2004). It is difficult to establish the effect of physical activity on development. While some researchers argue that exercising would not normalise high blood pressure or have influences on lipoprotein levels, others examined that high levels of physical fitness relate to a lower risk of the development of CVD (Biddle et al., 2004).

Finally, overall physical well-being has been linked to better psychosocial outcomes such as self-esteem, mental health, and cognitive functioning (Biddle et al., 2004). Higher levels of PA are associated with better quality of life and well-being (figure 1).

2.4 Socioeconomic background

According to the Ecological Systems Theory (EST), development, or change in an individual must be considered within an ecological context. For adolescents, the ecological context includes their social network of family, friends, and school (Davison & Birch, 2001). Several mechanisms, such as parental support, family cohesion or parenting style, affect dietary patterns, sedentary behaviour, and physical activity (Loprinzi et al., 2012). One can think of the following factors influencing adolescents' weight status: types of foods available in the home, nutritional knowledge, family TV watching, peer and sibling interactions, et cetera. (Davison & Birch, 2001).

Another theory to explain the influence of parents' behaviour regarding physical activity on adolescents' levels of PA can be explained by the Social Cognitive Theory (Loprinzi et al., 2012). For example, parents influence PA levels by providing activity-related support, discussing PA, providing encouragement to participate in PA, or signing children up for PA programs. Different parenting styles (e.g., authoritative, authoritarian, permissive, and neglectful) control and accommodate a certain amount of PA (Loprinzi et al., 2012). Sex differences can also accommodate differences between social influence and level of physical activity. Chen and Kennedy (2005) found that there is a significant association between parenting style and PA of boys, but they did not find that association for girls' PA.

The context of the social network are in turn embedded in the contexts of community and society (Davison & Birch, 2001). The Ecological Systems Theory discusses the demographic, and societal context separately. The following factors are important predictors of an adolescent's weight status: socioeconomic status, neighbourhood safety, school physical education programs, accessibility to facilities (foods and recreational facilities), and ethnicity (Davison & Birch, 2001). For this research, the focus lies on the socioeconomic status of the

families. The monthly income of the household, the parents' occupation, and the parents' educational levels are determining the status of families (Loprinzi et al., 2012). Children and adolescents who grow up in a family with higher socioeconomic status are more likely to have transportation to sports clubs, good sports equipment, and a choice between different sports. Growing up in a family with lower socioeconomic status can result in less parental support and encouragement to participate in supervised physical activity which in turn can result in higher physical well-being (figure 1) (Ke et al., 2022).

2.5 Hypothesis

This study established three hypotheses based on the reviewed literature and research questions. The first hypothesis holds that the older adolescents get, the less active they are. This is because physical activity decreases during adolescence (Biddle et al., 2004). The second hypothesis is that adolescents with higher levels of physical activity have a positive relationship with higher levels of physical well-being. Furthermore, we assume a link between physical activity levels and socioeconomic status. As a result, the third hypothesis proposes that adolescents from higher socioeconomic backgrounds have higher levels of PA and therefore higher levels of physical well-being than adolescents from lower socioeconomic backgrounds.

3. Methodology

3.1 Data and ethical considerations

The study's goal was to test and predict a relationship between adolescent physical activity levels, physical health outcomes, and the effects of socioeconomic factors. In this study, the KiGGS dataset is used to investigate this relationship. Between 2003 and 2006, the Robert Koch Institute in Germany conducted a comprehensive longitudinal cohort examination survey on physical and mental health measures among German children aged 0 to 17 years old. This study utilizes cross-sectional data from this dataset. The KiGGS dataset has no reporting bias as some health markers are collected through physician's examinations (Mauz et al., 2020; Robert Koch Institut, 2020). To select participants, a two-stage sampling protocol was used. Through questionnaires, 17,640 participants took part in the study. The study was carried out in accordance with the medical ethics committee's ethical guidelines. Participation was voluntary, and all participants were anonymized before the data was released. Furthermore, participants were not required to answer all questions, and if a question was deemed inappropriate for their age, it was skipped or answered by their parents (Mauz et al., 2020).

Because the goal of this study is to find patterns and regularities in data to represent the outcome of some underlying processes, quantitative research is carried out (Clifford et al., 2010). Secondary data is used because a larger dataset is more suitable to answer the research questions. Furthermore, the KiGGS dataset contains all variables needed for the analysis. Replicability and transparency were ensured by thoroughly describing the data analysis process.

3.2 Sample selection

The dataset contains 1.206 variables, the most relevant variables on physical activity, physical health, and socioeconomic status are used. The variables regarding the level of physical activity were different for the age groups 3 - 10 years and 11 - 17 years old because adolescents aged 11 to 17 years answered the questions themselves rather than their parents (Kurth et al., 2008). The age group 3 to 10 years is excluded from the study due to variable inconsistency and potential bias from parental responses. As a result, German adolescents aged 11 to 17 are the study's target population.

Of the full KiGGS study population, we selected only adolescents, who had no missing values in the key variables (Table 1). Finally, we obtained a sample of $N = 5,197$ adolescents aged 11 - 17 years with *46.6% females* and *53.4% males*.

3.3 Variables

3.3.1 Dependent variable

The dependent variable is physical health outcome. This outcome is measured using the continuous variable 'KINDL - Physical Well-Being'. The variable measures physical well-being on a scale from 0 to 100 and is therefore suitable to run a regression. The KINDL variable is based on the KINDL-R generic health-related quality of life (HRQOL) questionnaire, which is used internationally. This questionnaire consists of 24 items and is subdivided into six subscales, physical well-being is one of these subscales (Kurth et al., 2008). It is appropriate to use as a variable about physical health outcomes due to the health-related quality.

3.3.2 Main independent variables

Firstly, the relationship between physical health outcomes with different levels of physical activity is assessed using the variables: 'Physical activity: hour/week' (continuous and measured in duration) and 'Physical Activity' (measured using an ordinal scale). Using these two variables, the research can analyse if adolescents meet the WHO requirements and how often adolescents get physical exercise. The ordinal variable 'Physical Activity' is ranked as follows: 1: Almost every day, 2: 3-5 times per week, 3: Almost 1-2 times per week, and 4: Almost 1-2 times per month.

Secondly, the relationship between socioeconomic status (SES), physical activity and physical health will be analysed using a SES Index based on a German index by Winkler and Stolzenberg. This index is based on education, occupation, and income. The result is a score ranging from 3 to 21 and made up entirely of whole numbers (Lampert et al., 2018). This results in the identification of three groups: 'Low SES' (score 3-8), 'Middle SES' (score 9-14), and 'High SES' (score 15-21). The KiGGS dataset also includes separate socioeconomic status indicators, which will be used as independent variables. In addition to the variable 'Social Class,' the variables 'Monthly Income per Household,' 'Employment Status Mother,' and 'Employment Status Father' are used to assess families' socioeconomic status.

3.3.3 Control variables

To enhance the internal validity, and to control for possible influential factors, the following variables were included in the analysis: ‘Age group’, ‘Sex’, ‘Living Environment’, ‘Heart Disease’, and ‘BMI according to Kromeyer-Hauschild’. According to the literature, physical activity levels decrease during adolescence (Stabelini et al., 2022). Because of the predicted influence of age, it is controlled. Graf et al. (2014) used the KiGGS dataset to make recommendations for increasing physical activity among children and adolescents. They discovered that boys participate in sports at a higher rate than girls. As a result, gender differences must be considered. According to the Ecological Systems Theory, the context and environment in which adolescents grow up have an impact on their physical well-being. As a result, the living environment is incorporated as a control variable. Because adolescents with heart disease may be less active and have lower physical well-being, the variable 'Heart Disease' is controlled. Finally, 'Body Mass Index (BMI) according to Kromeyer-Hauschild' is included as a control variable. BMI is calculated as body weight divided by height squared (kg/m2) and is used to determine underweight, overweight, and obesity. The kg/m2 ratio changes during childhood, so the cut-off varies by age (Schienkiewitz et al., 2018). The Kromeyer-Hauschild classification system is utilized in the analysis because it is the German classification system. Children and adolescents with a $P > 90$ are considered overweight, while a $P > 97$ is associated with obesity, according to Kromeyer-Hauschild (Schienkiewitz et al., 2018).

3.4 Data analysis

The data from the KiGGS dataset is analysed using SPSS 29.0 to answer the research questions. Using the dependent variable ‘KINDL – Physical well-being’, main independent variables, and control variables, different tests have been performed. P values less than 0.05 were considered statistically significant for all test results. Because no single variable can explain the outcome, multiple variables were examined.

First, a table with descriptive statistics is created to describe the basic features of the dataset and to compare mean rankings for physical well-being, hours of physical activity, and socioeconomic status. Descriptive statistics were also used to compare the percentages within the variables. The age variable is measured using two categories. The first category contains data on adolescents aged 11 to 13, while the second contains data on adolescents aged 14 to 17. In terms of the living environment, a new variable was created by combining the three urban categories into one category: 'Urban'. As a result, a binary variable with two categories emerged: rural and urban. The variable 'Monthly Income per Household' originally had 13 categories but was reduced to seven in this study to generate more understandable results (table 1). Finally, the employment status of both parents is used as an indicator of socioeconomic status. The original variables (mother and father) had six categories; this has been reduced to two ('unemployed' and 'employed').

The variables 'Physical Activity,' 'Social Class according to Winkler-Index,' 'Employment Mother,' 'Employment Father,' and 'Monthly Income per Household' have been

transformed into dummies using transform -> recode into different variables. Table 1 lists the reference categories.

The first multiple linear regression was used to investigate the relationship between physical health outcomes and physical activity. Multiple linear regression is applied because "multiple regression analysis allows researchers to assess the strength of the relationship between an outcome (the dependent variable) and several predictor variables as well as the importance of each of the predictors to the relationship, often with the effect of other predictors statistically eliminated." (Petchko, 2018, p. 259). The dependent variable was entered into the model alongside the independent variables: 'Physical Activity: hours/week' and 'Physical Activity', and the control variables.

A Chi-Square test was utilized to determine the relationship between socioeconomic factors and physical activity levels. According to the literature, different levels of socioeconomic status can lead to an increase or decrease in physical activity. The variables 'Social Class according to Winkler-Index' and 'Physical Activity' were entered into Crosstabs and the Chi-Square statistic was selected. Chi-Square is chosen because it can evaluate the relationship between categorical variables.

After that, a second multiple linear regression was performed with the same dependent variable and including all main independent variables to see if the relationship is significant. The variables were added to the regression using 'Enter'. The results have been discussed and were then compared with findings in the literature.

4. Results

4.1 Descriptive statistics

Table 1 shows the frequency distributions for the predictors of physical well-being in adolescents. It includes the frequencies, mean ranking, standard deviation, minimum value, and maximum value of the variables of physical activity levels. Predictors concerning SES have been included as well, these are the variables containing information about parents' employment status, monthly income, and social class according to Winkler Index.

Variable	**Category**	**N, %**	**Mean**	**Std. Dev.**	**Min, max**
Sex	Female (ref. category) Male	2,423, 46.5% 2,774, 53.5%			
Age	11 – 13 years (ref. category) 14 – 17 years	2,487, 47.9% 2,710, 52.1%			
Living Environment	0: Rural (ref. category) 1: Urban	1,191, 22.9% 4,006, 77.1%			

BMI according to Kromeyer-Hauschild 2001	Underweight (<P10) (ref. category) Normal weight Overweight (>P90 – P97) Obese (>P97)	399, 7.7% 3,910, 75.2% 514, 9.9% 374, 7.2%			
KINDL- Physical Well-Being	Male Female Total	2,774, 53.5% 2,423, 46.5% 5,197, 100%	77.02 72.60 74.96	16.400 17.242 16.940	0, 100 0, 100 0, 100
Physical Activity	1: Almost every day (ref. category) 2: 3-5 times per week 3: Almost 1-2 times per week 4: Almost 1-2 times per month	1,361, 26.2% 1,838, 35.4% 1,756, 33.8% 242, 4.7%	2.17	0.870	
Physical Activity Hours/Week	Male aged 11-13 years Male aged 14-17 years Female aged 11-13 years Female aged 14-17 years Total	1,322, 25.4% 1,452, 27.9% 1,165, 22,4% 1,258, 24.2% 5,197, 100%	8.30 8.46 5.50 5.18 6.96	8.788 8.024 5.680 5.548 7.390	1, 90 0, 80 0, 90 0, 96 0, 96
Social Class according to Winkler-Index	Lower social status (3-8) Middle social status (9-14) Higher social status (15-21)	1,275, 24.5% 2,568, 49.4% 1,354, 26.1%	11.68	4.253	3, 21
Employment Mother	Unemployed (ref. category) Employed	1,370, 26.4% 3,827, 73.6%			
Employment Father	Unemployed (ref. category) Employed	533, 10.3% 4,664, 89.7%			
Monthly Income per Household	< 500 € (ref. category) 500 - < 1,250 € 1,250 - < 2,000 € 2,000 - < 3,000 € 3,000 - < 4,000 € 4,000 - < 5,000 € > 5,000 €	39, 0.8% 539, 10.4% 1,150, 22.1% 1,952, 37.6% 905, 17.4% 386, 7.4% 226, 4.3%			

Table 1: Descriptive statistics

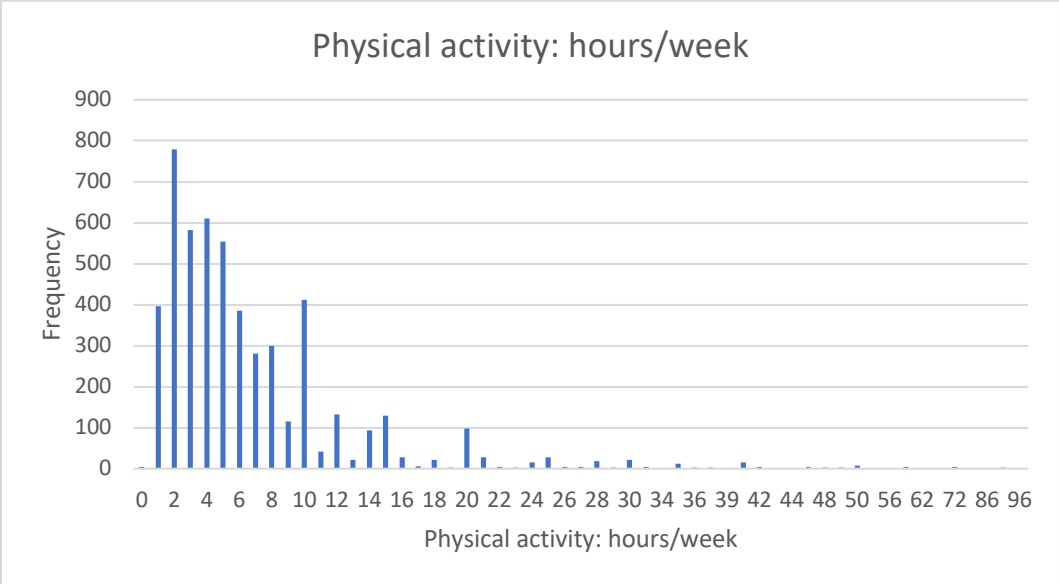

Figure 2: Hours of physical activity levels per week of the respondents

The proportion of males and females was nearly equal, as were the age groups 11 to 13 years and 14 to 17 years (table 1). Figure 2 depicts a bar chart with data on weekly physical activity hours. Most frequencies lie between 1 to 10 hours, with some outliers to the right. The average time spent on physical activity per week for an adolescent is *6.96* hours. Table 1 shows that there is a difference in age and sex. Males exercise more than females, according to the literature. The mean ranking for males is *8.30* for 11 to 13 years old and *8.46* for 14 to 17 years old. For females, the age group 11 to 13 years old corresponds with a mean ranking of *5.50* and 14 to 17 years old *5.18*. In this sample, the levels of physical activity of adolescents in Germany do not differ substantially among different ages.

The number of times that adolescents actively participate in sports corresponds to a mean of *2.17*, with the categories with the highest percentages being 3 to 5 times per week and 1 to 2 times per week, respectively.

4.2 Analysis of the first multiple linear regression regarding physical activity levels

Multiple linear regression was used to test if levels of physical activity and the hours spent on physical activity significantly predicted physical well-being. Table 1 shows that males have slightly higher physical well-being (*77.02*) compared to females (*72.60*). The first linear regression utilized 'KINDL - physical well-being' as the dependent variable and levels of PA as independent variables. The control variables were also added to the model.

Model Summary

Regression Statistics Model 1	
R	.198[a]
R Square	.039
Adjusted R Square	.037
Std. Error	16.62115
Observations	5,197

Note: [a]: predictors: (Constant), Male, 14 – 17 years, Urban, PA 3 to 5 times per week, PA Almost 1 to 2 times per week, PA Almost 1 to 2 times per month, Physical activity: hours/week, Heart disease, BMI Normal weight, BMI Overweight, BMI Obese

ANOVA

Model		*Sum of Squares*	*Df*	*Mean Square*	*F*	*Sig.*
1	Regression	58731.003	11	5339.182	19.326	<.001[b]
	Residual	1432420.935	5,185	276.262		
	Total	1491151.938	5,196			

Note: [b]: predictors: (Constant), Male, 14 – 17 years, Urban, PA 3 to 5 times per week, PA Almost 1 to 2 times per week, PA Almost 1 to 2 times per month, Physical activity: hours/week, Heart disease, BMI Normal weight, BMI Overweight, BMI Obese

Coefficients						
		Unstandardized coefficients		Standardized coefficients		
Model		*B*	*Std. Error*	*Beta*	*t*	*Sign.*
1	(Constant)	78.163	1.123		69.615	<.001
	Sex (ref. female)	-3.946	.476	-.116	-8.293	<.001
	Age (ref. 11-13 years)	-1.018	.467	-.030	-2.177	.030
	Living environment (ref. rural)	-.206	.550	-.005	-.374	.708
	PA 3 to 5 times per week	-.685	.612	-.019	-1.120	.263
	PA Almost 1 to 2 times per week	-3.933	.662	-.110	-5.937	<.001
	PA Almost 1 to 2 times per month	-6.352	1.216	-.079	-5.226	<.001
	Physical activity: hours/week	-.064	.035	-.028	-1.841	.066
	Heart disease	-2.352	1.440	-.022	-1.633	.102
	BMI Normal weight	2.408	.876	.061	2.748	.006
	BMI Overweight	1.046	1.110	.018	.942	.346
	BMI Obese	-2.930	1.199	-.045	-2.444	.015

Note: a. Dependent Variable: KINDL- Physical well-being 100 (EFB)

Table 2: Model summary, ANOVA table, and coefficient table of the first multiple linear regression with levels of physical activity

Table 2 shows the result of the first multiple regression. All cases were included in the model (observations *5,197*). The overall regression was significant because P <*0.001* < *0.05* (ANOVA Table). From the model summary, one can see that the results of the regression indicated the predictors explained 3.9% of the dependent outcome (R^2=.039). Looking at the coefficients table, one can see that not all the variables are significant. There was a negative but small effect of physical activity: hours/week on physical well-being, yet it was not statistically significant (*P 0.66 > 0.05)*. The variables that do predict and were statistically significant are sex, age, frequency of physical activity, and BMI.

The Beta Coefficient (*B*) is the coefficient of the change of the dependent variable when the independent variable changes with one. In order to determine which variables explain the outcome, the Beta Coefficient must be interpreted. For age, the reference category is adolescents aged 11 to 13 years old. The Beta (*B*) coefficient for adolescents aged 14 to 17 years old decreases compared to the reference category. Meaning that being older corresponds with lower physical well-being. Not all the dummy variables for the level of physical activity are significant (sign. *.263 > 0.05*), however for PA almost 1 to 2 times per week and PA almost 1 to 2 times per month, it is seen that Beta decreases (*B = -3.933* and *B = -6.352*) indicating that physical well-being decreases when adolescents are more inactive. This corresponds with the literature saying that less physical fitness and exercise correspond with lower physical well-being.

Lastly, obesity has a negative Beta coefficient (*-2.930*), because it is statistically significant, we can assume that being obese correlates with a decrease in physical well-being.

4.3 Analysis of the Chi-Square Test and the second multiple regression regarding physical activity levels and socioeconomic status

The frequency distribution of social class according to Winkler-Index is shown in table 1. The mean score in the Index was *11.68*. Meaning that the mean class was the middle class because the score lies between 9 and 14. Almost half of the participants are from families with a middle socioeconomic status (*49.4%*). Regarding the employment status of the parents, it is seen that most parents have a job. The employment rate for mothers is *73.6%* and for fathers, it is *89.7%*. Regarding income, most households have an income between 2,000 - < 3,000 € and 1,250 - < 2,000 €.

Physical activity * Social Class according to Winkler Crosstabulation

Count

		Social class according to Winkler			Total
		Low SES	Middle SES	High SES	
Physical activity	Almost every day	376	669	316	1,361
	3 to 5 times per week	423	883	532	1,838
	Almost 1 to 2 times per week	402	898	456	1,756
	Almost 1 to 2 times per month	74	118	50	242
Total		1,275	2,568	1,354	5,197

Chi-Square tests

	Value	*Df*	*Asymptotic Significance (2-sided)*
Pearson Chi-Square	27.167[a]	6	<.001
Likelihood Ratio	26.932	6	<.001
Linear-by-Linear Association	1.392	1	.238
N of Valid Cases	5,197		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 59.37.

Symmetric Measures

		Value	Asymptotic Standard Error[a]	Approximate T[b]	Approximate Significance
Nominal by nominal	Phi	.072			<.001
	Cramer's V	.051			<.001
	Contingency Coefficient	.072			<.001

Measure of agreement	Kappa	.004	.009	.477	.634
N of Valid Cases		5,197			

Note: a. Not assuming the null hypothesis. b. Using the asymptotic standard error assuming the null hypothesis.

Table 3: Chi-Square Test for a relationship between socioeconomic status and physical activity

Table 3 shows the Chi-Square test that was performed to test the relationship between SES and the level of PA. Also, the strength of this relationship can be determined when looking at the symmetric measures. From the cross table in table 3, it is evident that the most prevalent score of SES was Middle SES with *2,568* cases. Within the middle class, most adolescents were exercising almost 1 to 2 times per week. The least prevalent score was Low SES with *1,275* cases. The Pearson Chi-Square statistic has a value of *27.167* which indicates that the data might not be a good fit for the model because the sample data does not fit the population data. This also becomes clear when looking at the strength of the relationship which can be determined when looking at Phi and Cramer's V. Although the model is significant (*<0.001* is smaller than *0.*05), it can be concluded that there is a (very) weak relationship between the variables (*0.072 and 0.051* respectively).

Although there is a (very) weak relationship between socioeconomic status and levels of physical activity, multiple linear regression is performed to test the relationship with physical health outcomes and other factors that might play a role in this relationship besides social class according to Winkler-Index and the categorical variable for PA levels.

Model Summary

Regression Statistics Model 1	
R	.219[a]
R Square	.048
Adjusted R Square	.044
Std. Error	16.56449
Observations	5,197

Note: [a]: predictors variables

ANOVA

Model		*Sum of Squares*	*Df*	*Mean Square*	*F*	*Sig.*
1	Regression	71222.636	21	3391.554	12.361	<.001[b]
	Residual	1419929.302	5,175	274.382		
	Total	1491151.938	5,196			

Note: [b]: predictors: (Constant), Male, 14 – 17 years, Urban, PA 3 to 5 times per week, PA Almost 1 to 2 times per week, PA Almost 1 to 2 times per month, Physical activity: hours/week, Heart disease, BMI Normal weight, BMI Overweight, BMI Obese, SES Middle, SES High, Income 500 - < 1250, Income 1250 - < 2000, Income 2000 - < 3000, Income 3000 - < 4000, Income 4000 - < 5000, Income > 5000, Mother employed, Father employed

Coefficients

Model		Unstandardized coefficients		Standardized coefficients		
		B	*Std. Error*	*Beta*	*t*	*Sign.*
1	(Constant)	74.612	2.889		25.828	<.001
	Sex (ref. female)	-3.936	.475	-.116	-8.293	<.001
	Age (ref. 11-13 years)	-1.165	.468	-.034	-2.490	.013
	Living environment (ref. rural)	-.523	.551	-.013	-.950	.342
	PA 3 to 5 times per week	-.803	.611	-.023	-1.316	.188
	PA Almost 1 to 2 times per week	-3.914	.661	-.109	-5.926	<.001
	PA Almost 1 to 2 times per month	-6.146	1.213	-.076	-5.066	<.001
	Physical activity: hours/week	-2.328	1.436	-.022	-1.621	.105
	Heart disease	-2.328	1.436	-.022	-1.621	.105
	SES Middle	.158	.671	.005	.236	.814
	SES High	.360	.911	.009	.396	.692
	Income 500 - < 1250	1.948	2.751	.035	.708	.479
	Income 1250 - < 2000	3.999	2.719	.098	1.471	.141
	Income 2000 - < 3000	4.952	2.737	.142	1.809	.070
	Income 3000 - < 4000	6.405	2.800	.143	2.287	.022
	Income 4000 - < 5000	7.769	2.902	.120	2.677	.007
	Income > 5000	7.818	3.007	.094	2.600	.009
	Mother employed	-.662	.540	-.017	-1.225	.220
	Father employed	-1.224	.699	-.027	-1.752	.080
	BMI Normal weight	2.519	.875	.064	2.878	.004
	BMI Overweight	1.360	1.109	.024	1.226	.220
	BMI Obese	-2.337	1.204	-.036	-1.940	.052

Note: a. Dependent Variable: KINDL- Physical well-being 100 (EFB)
* P < 0.05

Table 4: Model Summary, ANOVA and Coefficients of second multiple linear regression including SES factors

In the model summary (table 4), one can see that the proportion of explained variance was rather small with Nagelkerke's R^2 of *.048*. The results show that the model is significant because *P <0.001 < 0.05* (ANOVA Table). There was a positive but small effect of socioeconomic factors on physical well-being, yet it was not statistically significant. The SES variables significantly influencing physical well-being are monthly income of 2,000 - > 5,000 €. Social class according to Winkler-Index and the employment status of the parents do not significantly influence the outcome variable. Therefore, we cannot draw any conclusions regarding the effect of SES on the physical well-being of adolescents.

5. Discussion

5.1 Physical activity levels at different ages

Based on the theoretical findings, it was expected that adolescents would not meet the recommendations set by the WHO of 60 minutes of moderate to vigorous activity per day (WHO, 2020). The sample's mean PA level was 6.96 hours, and only 26.2% of the adolescents exercised every day, indicating that they do not meet WHO recommendations. However, the mean of males' physical activity per week was above the recommendation. Figure 2 also shows that in this sample, not many adolescents have more than 10 hours of physical exercise per week.

According to Biddle et al. (2020), it is hard to accurately measure physical activity. Short-term and spontaneous movement is frequently overlooked. Variables containing information about the frequency with which children attend sports clubs, play outside, play inside, and the intensity of activities may aid in assessing spontaneous and short-term movement. However, this information was only available for children aged 3 to 10, and the responses were graded by parents. As a result, this study was unable to analyse the data. Because it is difficult to accurately measure physical activity, the variable containing information about physical activity hours spent per week is likely to differ from figure 2.

Adolescents become less active as they get older, according to Biddle et al. (2004). Literature also found that boys are more active compared to girls (WHO, 2021). According to the theoretical findings, the results show that the mean ranking of hours per week spent on physical activity is higher in males than in females. Furthermore, the results show that physical activity duration per week increases slightly in older males but not in older females. It was hypothesized that age is negatively correlated to the level of physical activity. We cannot confirm the hypothesis because of the minor increase in males and the minor decrease in females, so it is rejected. One possible explanation for these findings is that there is little variation between ages 11 and 17 because it is measured in only two groups. Therefore, it is more difficult to calculate differences between younger and older ages.

5.2 Physical well-being with different levels of physical activity

The second sub-question regarding how physical health differs by different physical activity levels can partly be explained using the model. There was a significant relationship between physical well-being and the frequency of physical activity. Also, the correlation in this relationship was positive. The more frequent adolescents exercise the higher their physical well-being. We could not confirm the suggested positive effect of physical activity: hours/week on physical well-being (see hypothesis two). According to the literature, obese children are more physically inactive and are more at risk for developing diseases such as CVD (Hills et al., 2011). In accordance with the literature, obese children are having a negative correlation with physical well-being.

However, it must also be critically questioned whether adolescents move less because of a decrease in physical well-being or the other way around. That a reduction in PA results in frustration and increased inactivity (Biddle et al., 2020).

5.3 Role of the socioeconomic status in the relationship

It was hypothesized that there was a link between levels of physical activity and socioeconomic status. According to the Social Cognitive Theory, the level of PA is influenced by parents through providing activity-related support, discussing PA, or encouragement to participate in PA (Loprinzi et al., 2012). The results from the Chi-Square test showed a (very) weak relationship between PA level and SES. Although they do support the evidence found in the literature, the relationship is not as strong as expected.

We could not confirm the suggested positive effect of socioeconomic status on physical well-being (see hypothesis three). Although the entire model was significant, no single variable (except some categories for income) explains the dependent outcome variable. A possible explanation for this could be that the outcome variable only measures on a scale from 0 to 100 and therefore it is difficult to establish what the significant influence of SES factors is on physical well-being. It could be the case that socioeconomic factors have a significant result when measuring generic health-related quality of life without dividing physical well-being as a subscale (Kurth et al., 2008).

5.4 Reflection and limitations

A secondary database was used to perform the study. Limitations resulting from using existing data rather than collecting own data is the assessment of certain variables. The level of physical activity was not equal among all ages. Therefore, the research could only focus on adolescents rather than children aged 3 to 17 years old. Also, due to a lack of accuracy in assessing physical activity, health benefits are more difficult to find in studies and in the results. Another limitation regarding the KiGGS database is that physical health is only measured as physical well-being on a scale from 0 to 100. While it is clear what physical well-being means, it is not entirely clear which factors the Robert Koch Institute in Germany included in the assessment of physical well-being.

Studies were contradicting regarding the relationship between socioeconomic status and PA or physical health outcomes. My results did not show a significant relationship between physical well-being and socioeconomic status variables (except income). While this could be because my sample was not a good data fit, it could also be a problem of the non-existence of the relationship. The advantage of using the dataset was the opportunity to work with a larger sample.

6. Conclusion

6.1 Conclusion

To answer the research question: '*What is the relationship between the level of physical activity of* adolescents *aged 11-17 years and physical health outcomes in Germany?'* one can conclude that higher levels of physical activity positively affect physical well-being. Literature provided evidence for the link between physical inactivity and a decrease in physical well-being, the relationship remains moderate to weak due to the number of factors that play a role. The results of this study showed that not all adolescents did not meet the guidelines set by WHO and that the effect on physical well-being is not very strong. According to the literature, there is some evidence that higher levels of physical activity reduce the risk of developing CVD. In this research, there is no significant relationship between heart disease and therefore we cannot draw any conclusion on that.

This research also aimed to examine the effects of levels of physical activity and socioeconomic status on physical health outcomes. According to the literature, physical well-being can be stimulated by getting more exercise. Adolescents are influenced by their social network of family, friends, and school but also by community settings and society. Higher socioeconomic status is associated with higher levels of physical well-being. This study found no significant results between SES factors and physical well-being.

6.2 Future research and policy implications

Besides physical activity levels and the impact of certain socioeconomic factors, there are other factors influencing the physical well-being of an adolescent. It would be interesting to see which factors are also playing a major role in this. Besides that, a longitudinal cohort study of children aged 3 to 17 years could help to provide proof of causality between levels of physical activity and the effects on physical well-being. Studying the same children and adolescents over time would give more insight. This research did not discuss the influence of sedentary behaviour, but it would be interesting to see how that impacted levels of PA in adolescents over the past decades. For policy implications, the German government can stimulate organisations such as the Deutscher Olympischer Sportbund to organise even more projects and events which adolescents can participate in. In the results, there was not a significant relationship between socioeconomic status and physical well-being, but future research is needed to see if this data was not a good fit for the model or if the relationship is non-existent.

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