PAAH
PHYSICAL ACTIVITY AND HEALTH

Physical Activity and Depression/Anxiety Symptoms in Adolescents – the Young-HUNT Study

RESEARCH

MARTHE BJERKAN
VEGAR RANGUL
KNUT SKJESOL
SVEIN OLAV ULSTAD

*Author affiliations can be found in the back matter of this article

ubiquity press

ABSTRACT

Children and adolescents who report mental health problems, such as depression and anxiety, has increased steadily in recent years. At the same time there is also a reduction in physical activity level among children and adolescents. The present study aimed to explore the association of physical activity and participation in sport activity with depression and anxiety symptoms stratified by sex and age group. Cohort data was obtained from the Trøndelag Health Study (Young-HUNT4). The analyses were based on cross-sectional data on 7,347 participants. Multinominal logistic regression models were used to estimate the association between physical activity and participation in sport activity with depressive/anxiety symptoms. The analyses showed that depression and anxiety symptoms increased with age and that girls were at an increased risk of developing depressive/anxiety symptoms than boys. For physical activity, the analyses suggested that inactive adolescents had a higher possibility of experiencing anxiety and depression symptoms than active adolescents. This applied for both girls (OR = 1.51, $p < 0.001$) and boys (OR = 1.29, $p = 0.037$). For sport activity, adolescents with a low activity level had a higher probability of experiencing symptoms of anxiety and depression than adolescents with high activity level. This also applied to both girls (OR = 1.75, $p < 0.001$) and boys (OR) = 1,55, $p = 0.007$). The study indicates that adolescents who are regularly physically active in sport activities have a lower possibility of experiencing symptoms of depression and anxiety than those who are physically less active.

CORRESPONDING AUTHOR:
Svein Olav Ulstad
Nord University, NO
svein.o.ulstad@nord.no

KEYWORDS:
Physical activity; Sport activity; Symptoms of depression; Anxiety; Young-HUNT

TO CITE THIS ARTICLE:
Bjerkan, M., Rangul, V., Skjesol, K., & Ulstad, S. O. (2022). Physical Activity and Depression/Anxiety Symptoms in Adolescents – the Young-HUNT Study. *Physical Activity and Health*, 6(1), pp. 73–85. DOI: https://doi.org/10.5334/paah.185

INTRODUCTION

Depression is one of the most common mental health disorders worldwide. In Europe, approximately 9% of men and 17% of women experience depression during their lifetime (Smit, Shields & Petrea, 2016). The results of the Norwegian national cross-sectional Ungdata study shows that the percentage of girls and boys who experience mental illness, as symptoms of depression and anxiety, has increased steadily in recent years (Bakken, 2020), and that the physical activity level in both organized and unorganized activities among adolescents is decreasing (Bakken, 2020). Previous studies have also shown an association between decrease in physical activity levels and increase in depressive and anxiety symptoms (de Oliveira Oancea, Nucci et al., 2018; Jung, Lee, Lee et al., 2018; Liu, Ozodiegwu, Yu et al., 2017; Murphy, Sweeney & McGrane, 2020).

A survey conducted on 118.600 Norwegian adolescents showed that regardless of the geographical connection and place of residence in Norway, young participants answered that they had mental disorders, such as anxiety and depression (Bakken, 2019). In Norway, the percentage of adolescents in middle school who report mental illness varies from 13% to 16% depending on the adolescents' residency, and this percentage in high school is even higher (Bakken, 2019). The other Nordic countries, and countries such as Greece, the UK, the Netherlands and the USA, have shown a similar trend as the Norwegian data with an increase in depressive and anxiety symptoms among adolescents in recent decades (von Soest & Wichstrøm, 2013; Biddle, Ciaccioni, & Thomas, et al., 2019; Collishaw, Maughan & Natarajan et al., 2010; McMahon, Corcoran, O'Regan, et al., 2017; Sweeting, West & Young et al., 2010).

A study conducted by the Norwegian Sports Academy and National Institute of Public Health indicates an age-dependent decrease in physical activity in older children; and this applies to both light, and moderate and high intensity activities (Steene-Johannessen, Anderssen & Bratteteig et al., 2019). The 2019 Ungdata survey showed that the proportion of girls aged 15 years who exercised weekly had reduced from 77% to 73% until they were aged 19 years, while proportion of boys in the same age group who exercised weekly remained stable at approximately 76% (Bakken, 2019).

Studies in several countries and different cultures have shown that physically active people have lower levels of depressive and anxiety symptoms than physically inactive people (de Oliveira et al., 2018; Jung et al., 2018; Liu et al., 2017). A study by Stubbs, Koyanagi & Scuchu et al. (2016) including 178.867 people from 36 countries showed that people with a lower level of physical activity (defined as less than 150 minutes of moderate to high intensity physical activity per week) had higher levels of depression/anxiety than those with higher level of physical activity (Stubbs et al., 2016). In Norway, a previous study based on the young-HUNT data showed that boys who exercise for less than one day a week have twice the risk of developing depressive/anxiety symptoms than those who exercise for more than four days a week (Fløtnes, Nilsen & Augestad., 2011).

Physical activity through organized sports activity has a positive impact on adolescent development and reducing depressive/anxiety symptoms. Several studies have shown that participation in organized activities is associated with social benefits and fewer depression and anxiety symptoms (Randall & Bohnert, 2009; Bohnert, Aikins & Arola, 2013). Kleppang, Hartz & Thurston et al. (2018) also reported that a larger proportion of adolescents who were less physically active (≤3 times a week) in organized activity had more depressive/anxiety symptoms than those who were more physically active (>3 times a week) (Kleppang et al., 2018).

However, large population-based studies to evaluate the correlation of physical activity (PA) levels and participation in sport activity with depressive and anxiety symptoms needs to be examined more thoroughly. Identification of these relationships may help design accurate strategies for increasing engagement in PA and sport activity and improving mental health in adolescents. Therefore, the present study aimed to explore the association of PA and participation in sport activity with depressive/anxiety symptoms in adolescents stratified by sex and age group (13–15 years vs. 16–19 years) where general health and health habits were adjusted for.

METHODS

SUBJECTS

This study is based on data from Norwegian adolescents (aged 13–19 years) in the Nord-Trøndelag County. They participated in the adolescent group in the fourth round of the population-based Trøndelag Health Study (Young-HUNT4). The Young-HUNT4 survey collected data from 8,066 participants, and we included 7,347 participants in the present study. The adolescents who were included in Young-HUNT4 were students in middle school and high school, apprentices, young people with offers through the follow-up service, and young people at work. Of these, 3,522 were boys and 3,825 were girls. The majority of the participants were aged between 13 years and 19 years. The survey included interviews and questionnaires, as well as physical examinations, such as weight, height, blood pressure, lung function, sitting height, and hip size (NTNU, 2019). In addition to these physical variables, information was also collected about adolescents' tobacco and alcohol habits, stages of puberty, reading and writing difficulties, mental health, and physical activity. Since its inception in 1995, the young-HUNT survey has been completed four-times: Young-HUNT2 during 1999–2000, young-HUNT3 during 2006–2008, and young-HUNT4 during 2017–2019. The young-HUNT surveys invite all adolescents in the middle school and high school to participate (NTNU, 2019). The Nord-Trøndelag county is demographically comparable to Norway in terms of geography, economy, industry, income, age distribution, morbidity, and mortality (Fløtnes et al., 2011).

ANALYSIS OF DIFFERENCE

The analysis showed significant differences in the trends for inactivity (≤3 times/week) and activity (≥4 times/week): t (6467) = 13.175, $p < 0.001$. Therefore, active adolescents had fewer anxiety/depressive symptoms than inactive adolescents. There was a significant difference in the results for adolescents from both "low" and "moderate" sport activity level: t (4149) = 8.91, $p < 0.001$; and "moderate" and "high" sport activity level: t (3410) = 7.78, $p < 0.001$. Therefore, adolescents who were active in sport activity ≥1–3 times a week had fewer anxiety/depressive symptoms than those who participated in sport activity ≤1–3 times a month.

ETHICS

The Young-HUNT study is a voluntary health survey in which adolescents can decide whether or not to participate. All participants and the parents or guardians of those under the age of 16 years gave a written consent to participation and use of data for research. The study was approved by the Regional Committee for Medical and Health Research Ethics and by the HUNT's Data Access Committee.

PHYSICAL ACTIVITY

In young-HUNT4, PA was measured using a questionnaire that addressed the extent to which young people engaged in PA or training of moderate to high intensity in their spare time (Rangul, Holmen & Kurtze et al., 2008). The questions that assess the level of PA in adolescents have been used in school surveys conducted by the World Health Organization, showing good validity and reliability (Rangul et al., 2008). The question focused on obtaining information about the intensity and frequency of the activity; it was as follows: "Outside of school: How often do you participate in sports or PA so much that you get out of breath and/or sweat?". The subjects had six different response categories: "Never," "Less than once a week," "Once a week," "2–3 times a week," "4–6 times a week," or "Every day." Based on the Norwegian Directorate of Health's recommendations for PA (Norwegian Directorate of Health, 2019), the adolescents were divided into two categories: "Inactive" that included PA ≤3 times a week, and "active" that included PA ≥4 times a week (Rangul, Holmen & Bauman et al., 2011).

SPORT PARTICIPATION

The adolescents were asked two questions about their sport participation. This included organized training in sports teams, associations, gyms, and other physical activities. The questions asked were as follows: "How often do you participate in organized training (with sports teams or associations)?" and "How often do you participate in unorganized exercise with

others? (Example: playing soccer with friends, training at the gym/group classes, etc.)." Each question had five response categories: "Never," "≤2–3 times a month," "Once a week," "2–3 times a week," or "≥4 times a week." These response categories were further divided into three subcategories: "Low," which included organized activity ≤3 times a month; "Moderate," which included organized activity 1 to 3 times a week; and "High," which included organized activity ≥4 times a week. These categories have been used in previous young-HUNT studies, showing good reliability and validity (Guddal, Stensland & Småstuen et al., 2017).

SYMPTOMS OF ANXIETY AND DEPRESSION

We included a question that measures both depressive and anxiety symptoms. Eleven different claims were listed under this question. The adolescents were asked whether during the previous two weeks they had "Felt scared or anxious," "Felt tense or hurried (restless)," "Felt hopeless when thinking about the future," "Felt down and sad," or "Worried too much about different things." Symptoms of depression and anxiety were measured using a scale derived from the Hopkins Symptom Checklist. This scale has been previously used to measure indications of depression and anxiety and has been shown to be very similar to the full and non-abbreviated instruments (Strand, Dalgard & Tambs et al., 2003; Tambs & Moum, 1993). SCL-5 consists of five elements/statements, where each statement has four response categories ("Not bothered," "Slightly bothered," "Fairly bothered," and "Very bothered"). These response categories are rated from 1 to 4, where the recommended cutoff score for depressive/anxiety symptoms is 2.0 (Strand et al., 2003). Therefore, adolescents with values ≥2.0 will be categorized as having symptoms of anxiety/depression.

COVARIATES

Further, we collected information on general health (self-reported well-being) and health habits as adjustment variables. These variables have been used in previous young-HUNT studies (Ask, Langballe & Holmen et al., 2014). The adolescents were asked about their smoking habits with two questions: "Have you ever tried smoking (at least one cigarette)?" and "Do you smoke or have you smoked?". Body mass index (BMI) values were collected through physical measurements of weight and height. The BMI variable was adjusted for age. Values for the subject alcohol habits were collected with three questions: "Do you occasionally drink alcohol? (Alcoholic beer, wine, soda/cider, liquor or home-brewed)," "Have you ever drunk so much alcohol that you have been intoxicated (drunk)?" and "How often do you drink alcohol?".

STATISTICAL ANALYSES

All statistical analyses were performed using SPSS Statistics 26. Descriptive statistics are reported as counts and percentages. Crosstabs are used to present the number and percentage distribution of girls and boys for the variables PA and organized activity. Independent samples *t*-tests were used to compare depressive and anxiety symptoms between inactive and active PA levels, and between low, moderate and high levels of organized activity. Multinomial regression was used to examine the association of depressive and anxiety symptoms and PA with participation in organized activity for boys and girls aged 13–19 years with values for odds ratios to determine the strength of the connection between the variables. Baseline characteristics analyses and regression analysis were performed using a split file for gender.

RESULTS

CHARACTERISTICS OF THE STUDY PARTICIPANTS

A total of 3,522 boys and 3,825 girls were included in the study. The characteristics of the study participants showed that 31% (23% girls and 8% boys) of the adolescents included in the study were categorized as having symptoms of depression/anxiety. Crosstabs were used to elucidate the baseline characteristics of both main variables and covariates (Table 1). The analysis showed that symptoms of depression and anxiety decreased with activity level in adolescents, both boys and girls, who were active in sport activities than in those who were inactive. Regarding PA, there was a significant difference in anxiety/depressive symptoms between inactive and active girls and boys. In the group of girls categorized with symptoms of

Table 1 Characteristics of the study participants (N = 7,347).

	SPORT ACTIVITY						PHYSICAL ACTIVITY			
	GIRLS			BOYS			GIRLS		BOYS	
	LOW N (%)	MODERATE N (%)	HIGH N (%)	LOW N (%)	MODERATE N (%)	HIGH N (%)	INACTIVE N (%)	ACTIVE N (%)	INACTIVE N (%)	ACTIVE N (%)
Age										
13–15 years	212 *(21.8)*	738 *(41.0)*	320 *(56.9)*	231 *(25.4)*	657 *(43.1)*	340 *(44.3)*	776 *(33.8)*	500 *(46.8)*	697 *(36.3)*	541 *(41.6)*
16–19 years	759 *(78.2)*	1,062 *(59.0)*	262 *(43.1)*	678 *(74.6)*	868 *(56.9)*	428 *(55.7)*	1,523 *(66.2)*	569 *(53.2)*	1,223 *(63.7)*	759 *(58.4)*
BMI										
Underweight to normal	608 *(66.5)*	1,400 *(73.5)*	530 *(80.9)*	549 *(66.8)*	1,201 *(75.2)*	685 *(81.6)*	1,623 *(70.0)*	924 *(78.8)*	1,332 *(70.7)*	1,112 *(80.0)*
Overweight	205 *(22.4)*	379 *(19.9)*	109 *(16.6)*	165 *(20.1)*	273 *(17.1)*	134 *(16.0)*	485 *(20.9)*	214 *(18.3)*	350 *(18.6)*	229 *(16.5)*
Obese	101 *(11.1)*	125 *(6.6)*	16 *(2.4)*	108 *(13.3)*	122 *(7.6)*	20 *(2.4)*	210 *(9.1)*	34 *(2.9)*	201 *(10.7)*	49 *(3.5)*
Alcohol/intoxication										
Never alcohol nor intoxication	540 *(47.0)*	1,267 *(59.8)*	524 *(72.7)*	554 *(51.6)*	1,164 *(64.0)*	613 *(65.1)*	1,482 *(54.8)*	863 *(66.4)*	1,320 *(58.2)*	1,022 *(64.9)*
Intoxicated 1–10 times	325 *(28.3)*	502 *(23.7)*	131 *(18.2)*	*250 (23.3)*	336 *(18.5)*	165 *(17.5)*	693 *(25.6)*	267 *(20.5)*	460 *(20.3)*	292 *(18.5)*
Intoxicated > 10 times	*283 (24.7)*	350 *(16.5)*	66 *(9.1)*	*269 (25.1)*	*318 (17.5)*	*163 (17.3)*	530 *(19.6)*	170 *(13.1)*	489 *(21.5)*	261 *(16.6)*
Nonsmoker/smoker										
Non-smoker	995 *(92.2)*	2011 *(96.9)*	708 *(98.7)*	896 *(88.1)*	1,661 *(94.0)*	883 *(96.6)*	2,459 *(94.6)*	1,272 *(98.5)*	1,971 *(90.5)*	1,490 *(96.7)*
Smoker	*84 (7.8)*	*65 (3.1)*	9 *(1.3)*	121 *(11.9)*	106 *(6.0)*	31 *(3.4)*	140 *(5.4)*	19 *(1.5)*	208 *(9.5)*	51 *(3.3)*
Self-reported Wellbeing										
Good health	774 *(67.3)*	1,881 *(88.4)*	684 *(94.7)*	*831 (77.9)*	1674 *(91.5)*	907 *(95.8)*	2,122 *(78.3)*	1,231 *(94.1)*	1,910 *(83.9)*	1,521 *(95.7)*
Bad health	376 *(32.7)*	246 *(11.6)*	38 *(5.3)*	236 *(22.1)*	*156 (8.5)*	*40 (4.2)*	588 *(21.7)*	77 *(5.9)*	366 *(16.1)*	68 *(4.3)*
Anxiety/depression										
No symptoms	482 *(43.1)*	1172 *(56.7)*	497 *(71.0)*	772 *(75.9)*	1,512 *(86.3)*	786 *(86.7)*	1,312 (49.9)	845 *(66.9)*	1,765 *(81.1)*	1,312 *(86.9)*
Symptoms	637*(56.9)*	895*(43.3)*	203 *(29.0)*	245 *(24.1)*	241 *(13.7)*	119 *(13.2)*	1,320 (50.2)	418 *(33.1)*	410 *(18.9)*	197 *(13.1)*

anxiety and depressive, 76% were inactive and 24% were active. The same trend was observed in boys, i.e., 67.5% of those categorized with anxiety/depressive symptoms were inactive and 32.5% were active. In sport activity, 37% of the girls in the category "low" (sport activity for ≤3 times a month) were identified with symptoms of depression or anxiety, while only 12% of the girls in category "high" (sport activity for ≥4 times a week) were identified with the symptoms. The same trend was observed in the boys, with 41% in the category "low" and 20% in category "high" (Table 1).

PA LEVEL AND ANXIETY/DEPRESSIVE SYMPTOMS

The regression analysis showed that the odds of having symptoms of anxiety and depression were higher in both girls (OR = 1.51, $p < 0.001$) and boys (OR = 1.29, $p = 0.037$) who were inactive than in those who were active (Table 2).

Table 2 Association between physical activity level and symptoms of anxiety/depression among girls and boys.

* Model 1: Unadjusted.

Model 2: Adjusted for age, gender, alcohol, smoking, self-reported wellbeing and BMI.

		GIRLS					BOYS				
		B	*p*	OR	95% CI		B	*p*	OR	95% CI	
					LOWER	UPPER				LOWER	UPPER
Model 1*	Active	Ref.									
	inactive	0.710	0.000	2.034	1.768	2.339	0.436	0.000	1.547	1.287	1.860
Model 2#	Active	Ref.									
	inactive	0.413	0.000	1.512	1.263	1.810	0.256	0.037	1.292	1.015	1.643
	Age	0.222	0.032	1.248	1.019	1.529	0.084	0.415	1.088	.899	1.331
	Nonsmoker/smoker	0.709	0.017	2.031	1.135	3.637	0.924	0.000	2.518	1.630	3.889
	Alcohol/intoxicated	0.009	0.909	1.009	0.869	1.172	-0.142	0.056	0.868	0.750	1.004
	Self-reported Wellbeing	1.325	0.000	3.761	2.665	5.308	1.245	0.000	3.473	2.448	4.926
	BMI	0.369	0.000	1.446	1.234	1.694	0.400	0.000	1.492	1.278	1.741

PARTICIPATION IN SPORT ACTIVITY AND SYMPTOMS OF ANXIETY/DEPRESSION

The regression analysis showed that girls with a low level of sport activity had a 1.75-times higher likelihood of having symptoms of anxiety and depression than girls with a high level of sport activity (OR = 1.75, $p < 0.001$). For boys, the odds were lower (OR = 1,55, $p = 0.007$) (Table 3).

DISCUSSION

The results from this observational cohort study suggest that a higher proportion of girls are categorized as having anxiety/depressive symptoms than boys, and adolescents who are physically active and participate in organized sports have lower odds of having symptoms of anxiety/depression. The results also indicate that the odds of being classified with anxiety/depressive symptoms are 50% higher in girls than in boys, and 30% higher in boys with an inactive PA level than in those with active PA level. Adolescents with low level of sport activity have 1.7-times (girls) and 1.5-times (boys) higher likelihood of developing symptoms of anxiety/depression.

The study showed a clear difference in sex and occurrence of anxiety/depressive symptoms. Girls showed approximately 3-times the possibility of being categorized as having anxiety/depressive symptoms than boys. These results are not unique compared to those of other studies on the same topic. Comparable studies based on over 100.000 adolescents have found similar results for differences between boys and girls (Bakken, 2020; Bakken, 2019). The results of this study show that 23% of the girls reported a high incidence of anxiety/depressive symptoms that were above the cutoff score of 2.0. Therefore, every fourth girl in the cohort was categorized as having anxiety/depressive symptoms, consistent with observations of another study (Hume, Timperio & Veitch et al., 2011). Self-reported mental illness has increased gradually in girls since 2010, and according to the Ungdata survey

		GIRLS					BOYS				
		B	*p*	OR	95% CI		B	*p*	OR	95% CI	
					LOWER	UPPER				LOWER	UPPER
Model 1*	High[a]	Ref.									
	Low[b]	1.174	0.000	3.236	2.645	3.958	0.740	0.000	2.096	1.648	2.666
Model 2#	High[a]	Ref.									
	Low[b]	0.557	0.000	1.746	1.339	2.277	0.440	0.007	1.552	1.129	2.134
	Age	0.954	0.000	2.595	1.925	3.497	0.742	0.000	2.100	1.573	2.801
	Nonsmoker/smoker	0.713	0.079	2.039	0.921	4.517	1.016	0.000	2.761	1.585	4.809
	Alcohol/intoxicated	0.196	0.087	1.217	0.972	1.524	−0.282	0.006	0.764	0.618	0.921
	Self-reported Wellbeing	1.628	0.000	5.091	3.237	8.006	1.714	0.000	5.551	3.497	8.812
	BMI	0.354	0.003	1.424	1.132	1.793	0.514	0.000	1.672	1.351	2.070
Model 3*	High[a]	Ref.									
	Moderate[c]	0.626	0.000	1.870	1.554	2.250	0.051	0.669	1.053	0.832	1.333
Model 4#	High[a]	Ref.									
	Moderate[c]	0.354	0.002	1.425	1.133	1.793	−0.093	0.532	0.911	0.679	1.221
	Age	0.284	0.028	1.328	1.032	1.710	0.045	0.716	1.046	0.820	1.334
	Nonsmoker/smoker	−0.032	0.937	0.968	0.438	2.141	0.392	0.151	1.480	0.866	2.530
	Alcohol/intoxicated	0.236	0.025	1.267	1.030	1.557	−0.156	0.080	0.856	0.719	1.019
	Self-reported Wellbeing	0.515	0.024	1.673	1.069	2.619	0.616	0.010	1.852	1.161	2.954
	BMI	0.334	0.002	1.397	1.135	1.719	0.323	0.001	1.381	1.136	1.679

Table 3 Association between participation in sport activity and symptoms of anxiety/depression among girls and boys.

* Model 1 and model 3: Unadjusted.

Model 2 and model 4: Adjusted for age, gender, alcohol, smoking, self-reported wellbeing and BMI.

[a] High: Sport activity 4 times a week or more. [b] Low: Sport activity 3 times a month or less. [c] Moderate: Sport activity 1–3 times a week.

published in 2019, approximately one in four girls between the 10th grade and the end of high school experience being fairly or very bothered by mental problems (Bakken, 2019). Previous study based on the young-HUNT data showed similar trends. The results showed that of the 2000 adolecents included in the study 23% of girls and 11% of boys could be classified with symptoms of anxiety/depression (Fløtnes et al., 2011). There are several reasons why girls are more exposed to anxiety/depressive symptoms than boys. Walderhaug (2008) claimed that the reduction in serotonergic activity in anxiety/depressive symptoms affects girls to a greater extent than boys, and thus, girls report anxiety/depressive symptoms more frequently than boys. However, physical activity can help increase serotonergic activity (Martinsen, 2000) and reduce depressive symptoms (Chauloff, 1997; Hoffman, 1997; Dishman, 1997). Therefore, girls report higher levels of anxiety/depressive symptoms possibly because girls have lower level of activity than boys and are more sensitive to the reduction in serotonergic activity. Furthermore, based on the results presented in the present study, it may be argued that girls' low activity levels may affect their mental health and contribute to developing more anxiety/depressive symptoms than boys in the same age group.

Studies have been conducted on the effect of PA on anxiety/depressive symptoms in recent decades, but there is some disagreement about the extent to which PA has a positive effect on anxiety/depressive symptoms (Greist, Morgan & Goldston, 1987; Hughes, Casal & Leon, 1986; Østerås, Sigmundsson & Haga, 2017; Blumenthal, Babyak & Moore et al., 1999; McMahon, Corcoran, O'Regan, et al., 2017; Norris, Carroll & Cochrane., 1992; VanKim & Nelson, 2012; Singh, Clements & Fiatarone, 1997; Steptoe & Butler, 1996; Singh, Stavrinos & Scarbek et al., 2005; Stephens, 1988). We found that adolescents with a high PA level, which includes all types of PA that are exhausting or sweaty, report lower levels of anxiety/depressive symptoms. Moreover, a study claimed that PA must be regularly performed to have an impact on mental health (Hughes, 1986). This suggests that adolescents who are regularly physically active have a lower risk of developing symptoms of anxiety/depression. A study by Wiles, Stavrinos & Scarbek et al. (2012) supports these claims. They followed 5,423 adolescents at 14 years in Great Britain and found an association between the amount of PA and occurrence of depressive symptoms. The

study found no correlation between the intensity of PA and reduction in depressive symptoms; but it suggested that the amount of PA had a greater effect on the reduction in depressive symptoms than intensity of the PA.

Further, we observed a negative correlation between PA and anxiety/depressive symptoms, and a positive correlation between PA and self-reported well-being in both girls and boys. This indicates that adolescents who are physically active have fewer anxiety/depressive symptoms and higher well-being. The regression analysis supports this result and indicates that the odds of developing symptoms of anxiety/depression are higher in adolescents who are physically inactive than adolescents with high physical activity level. There are several comparable studies with similar results (Hughes et al., 1986; Camacho, Roberts & Lazarus et al, 1991; Farmer, Locker & Moscicki et al, 1998; Stephens, 1988; McMahon, Corcoran, O'Regan, et al., 2017; Norris, Carroll & Cochrane, 1990; Lindegård, Jonsdottir & Börjesson et al., 2015; Murphy et al., 2020). A recent study of Swedish adolescents showed similar results (Ma, Hagquist & Kleppang, 2020). The study does not include the same covariates as are in the present study, but includes social covariates, such as social background, family structure, and future educational plans. The results of the Swedish study showed that inactive adolescents have 75% higher odds of developing depressive symptoms than adolescents who participate in some PA daily (Ma et al., 2020). A study conducted on 14.804 college students in the United States also showed similar results in terms of PA, depressive symptoms, and mental well-being. Moreover, students who achieved health recommendations related to PA were less likely to report poor mental health than those who did not meet the health recommendations (VanKim & Nelson, 2012). Additionally, students who were good at socialization achieved the recommended PA to a greater extent than students who were poor at socialization (VanKim & Nelson, 2012). This indicates that PA conducted as a social event with other people may reduce depressive symptoms to a greater extent than activity conducted alone. Several other studies have also indicated an association between participation in organized activities and lower levels of anxiety/depressive symptoms (Bohnert et al., 2008; Fredricks & Eccles, 2006; Mahoney, Schweder & Stattin, 2002; McHale, Crouter & Tucker, 2001; Simpkins, Fredricks & Davis-Kean et al., 2006; Murphy et al., 2020). The results of the present study show that adolescents who are active in some organized and unorganized sport activity with others for less than once a week have more possibility of developing anxiety/depressive symptoms than adolescents who are active in organized or unorganized sport activity with others for once a week or more. This is also supported by the regression analysis, which showed higher odds for anxiety/depressive symptoms with a low sport activity level than a high sport activity level. A possible explanation for these results is the positive effect of social interaction. Studies have shown that social interaction is equally important as PA in reducing anxiety/depressive symptoms (Hughes et al., 1986; VanKim & Nelson, 2012). A recent study conducted in participants of the same age group (13–19 years) in Nord-Trøndelag shows that social support can lead to social coping beliefs, which in turn helps prevent social anxiety (Aune, Juul & Beidel et al., 2020). Untreated social anxiety can lead to the development of anxiety/depressive symptoms and other mental disorders in children and adolescents (Aune et al., 2020). These studies (VanKim & Nelson, 2012; Aune et al., 2020) show that the socialization of adolescents for organized activities is equally essential as PA for reducing anxiety/depressive symptoms. Social interaction and companionship in organized activities can also serve as a distraction from depressing thoughts for adolescents (Bahrke & Morgan, 1978). Thus, organized activity can reduce anxiety/depressive symptoms.

The results of the adjusted analyses show that anxiety/depression is a variable with relatively high odds in relation to inactivity and low and moderate participation in sport activity in both boys and girls. Therefore, it is important that young adolescents are more physically active, and it is unfortunate that the physical activity level in both organized and unorganized activities decrease with age. The same findings were applicable in the Physical Activity among Norwegian Children Study, where organized activities, had a clear decrease in participation in organized sports as adolescents get older (Bakken, 2019; Steene-Johannessen et al., 2019). In Norway, the percentage of young people who actively participate in organized sports activities gradually decreases when young people enter middle school and high school. While 70% of the boys and 69% of the girls in the 8th grade train with sports team one or more times a week, only 40% of the boys and 28% of the girls in the 3rd grade of high school participate in organized sports at least once a week (Bakken, 2019).

PRACTICAL IMPLICATIONS

The results of the present survey indicate the necessity of adolescents to engage in both organized and unorganized PA. We found a decrease in both PA and organized and unorganized activity when adolescents get older, and that a low physical activity level correlates with higher levels of anxiety/depressive symptoms. Organized activity is a very popular leisure activity, especially in children, but we noted an increasing dropout rate in adolescents in middle school and high school (Bakken, 2019). Here, organized sports have a responsibility to facilitate so that they meet the requirement of the Norwegian Sports Confederations promise of "sports for all". It is important that organized sports are open to all children and adolescents who wants to participate, regardless of prerequisites and skills. In this way, we can get adolescents with less anxiety/depressive symptoms.

Physical education is an arena where you reach out to all the young people and not just the young people who have chosen physical activity themselves. Here you also meet those young people who are not active in their spare time. Therefor it becomes important that all students have positive experiences in physical education, because there is a connection between positive experiences in physical education and physical activity in leisure time (Jaakkola et al., 2017; Kalajas-Tilga et al., 2022). Affecting change in constructs such as autonomous motivation in a PE context is related to positive change in motivation toward activities in an out-of-school context (Kalajas-Tilga et al., 2020). Perceived autonomy support from peers and parents is also important to the prediction of change in autonomous motivation toward, and actual participation in, leisure time physical activity (Kalajas-Tilga et al., 2020).

Recommendations that guidelines for mental health benefits should also include a context as well as intensity, type of activity and time spent, because sport activity together with others confers additional benefits above that provided by activity alone. Provision of a wider variety of physical activities through school PE and organizations should be a priority for the optimal development of physical and mental health among adolescents.

Our findings underscore the importance of keeping young people physically active. It will be important to do research, and make interventions to find out more about how to stimulate young people to physical activity, and we suggests that physical activity interventions should target these at-risk groups in the future. Aims should be targeted at those who are fully inactive, or least active, and females with a view to improving the mental health of those most in need.

STRENGTHS AND LIMITATIONS

STRENGTHS

This study has a large representative selection and provides an overview of the average adolescents in Norway. The study was not conducted at a specific school or selection, but with all adolescents between 13 and 19 years of age in the Nord-Trøndelag county, Norway. This includes all types of adolescents, such as those physically active and those who engage in other hobbies in their spare time. The study had a high response percentage—75% of the invited adolescents participated in the study. We also adjusted for background variables, such as smoking habits, alcohol habits, self-reported well-being, BMI, and age.

LIMITATIONS

First, this was a cross-sectional study and provided current data, in contrast to longitudinal study that would have provided alterations over time. In such a study, it is difficult to control whether young people report a higher level of activity or less anxiety/depressive symptoms than they actually have to improve the result. Moreover, boys may underreport their emotions (Koenig, Isaacs & Schwartz, 1994) and make it difficult to obtain an exact result for the anxiety/depression variable. Second, this study does not include PA that adolescents achieve through physical education and other physical activities at school. There can also be activities that the adolescent does not directly connect to PA or organized sport activity, which have not been included in these variables. The result in this study does not include a control of family history of anxiety/depression, social relationships, personality traits or diagnosis of mental health problems. PA in this study is measured by a questionnaire, and not by objective

methods as accelerometers. Adolescents tend to overestimate their PA level when it comes to self-report. Which is a limitation.

CONCLUSIONS

This study shows the increment in anxiety/depressive symptoms in adolescents aged between 13 and 19 years, and that girls are more prone to develop anxiety/depressive symptoms than boys. Further, the results show that there is an association between the amount of PA, both organized and unorganized, and the level of anxiety/depressive symptoms in adolescents. Overall, the results show that adolescents who are regularly physically active experience fewer symptoms of anxiety and depression than those who are comparatively less physically active. We also found that girls are more likely to be classified as having anxiety/depressive symptoms than boys. Additionally, by increasing the amount of PA and organized sport activity, adolescents can experience better well-being and fewer symptoms of anxiety and depression.

DATA ACCESSIBILITY STATEMENT

Data are available upon request from the HUNT Research Center. Interested, qualified researchers may request the data by contacting the HUNT Research Center, Levanger, Norwegian University of Science and Technology at hunt@medisin.ntnu.no.

ABBREVIATIONS

HUNT: The Trøndelag Health Study; NTNU: Norwegian University of Science and Technology; PA, physical activity.

ETHICS AND CONSENT

Participation in the study was voluntary. Inclusion in the Young-HUNT was based on written informed consent from participants aged 16 years or older, and from the parents of those aged under 16 years, in accordance with the Norwegian law. The Young-HUNT studies have been approved by the Regional Committee for Medical Research Ethics and the Data Inspectorate of Norway. All methods were performed in accordance with the relevant guidelines and regulations.

COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

MB was the main investigator and designed the study protocol in close collaboration with SOU and KS. Conceptualization of the study: MB, VR, SOU, and KS. Formal analysis: MB and SOU Methodology: VR, MB, SOU, and KS Writing – original draft: MB Writing and editing the manuscript: VR, MB, SOU, and KS Approval of the final version of the manuscript: VR, MB, SOU, and KS.

AUTHOR AFFILIATIONS

Marthe Bjerkan orcid.org/0000-0001-5253-0204
Nord University, NO

Vegar Rangul orcid.org/0000-0001-8863-0557
Nord University, NO

Knut Skjesol orcid.org/0000-0002-3842-9035
Nord University, NO

Svein Olav Ulstad orcid.org/0000-0003-3172-4370
Nord University, NO

REFERENCES

Ask, H., Langballe, E. M., Holmen, J., Selbæk, G., Saltvedt, I., & **Tambs, K.** (2014). Mental health and wellbeing in spouses of persons with dementia: the Nord-Trøndelag health study. *BMC Public Health*. DOI: https://doi.org/10.1186/1471-2458-14-413

Aune, T., Juul, E. M. L., Beidel, D. B., Nordahl, H. M., & **Dvorak, R. D.** (2020). Mitigating adolescent social anxiety symptoms: the effects of social support and social self-efficacy in findings from the Young-HUNT 3 study. *European Child & Adolescent Psychiatry*. DOI: https://doi.org/10.1007/s00787-020-01529-0

Bahrke, M. S., & **Morgan, W. P.** (1978). Anxiety reduction following exercise and meditation. *Cognitive Therapy and Research*, *2*(4), 323–33. DOI: https://doi.org/10.1007/BF01172650

Bakken, A. (2019). Ungdata 2019. Nasjonale resultater. (NOVA Rapport 9/19).

Bakken, A. (2020). Ungdata 2020. Nasjonale resultater. (NOVA Rapport 16/20).

Blumenthal, J. A., Babyak, M. A., Moore, K. A., Craighead, E., Herman, S., Khatri, P., Waugh, R., Napolitano, M. A., Forman, L. M., Appelbaum, M., Doraiswamy, M., & **Krishnan, R.** (1999). Effects of Exercise Training on Older Patients With Major Depression. *American Medical Association*, *159*. DOI: https://doi.org/10.1001/archinte.159.19.2349

Biddle, S. J. H., Ciaccioni, S., Thomas, G., & **Vergeer, I.** (2019). Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality. *Psychology of Sport and Exercise*, *42*, 146–155. DOI: https://doi.org/10.1016/j.psychsport.2018.08.011

Bohnert, A. M., Aikins, J. W., & **Arola, N. T.** (2013). Regrouping: Organized activity involvement and social adjustment across the transition to high school. Organized Out-of-School Activities: Settings for Peer Relationships. *New Directions for Child and Adolescent Development*, *140*, 57–75. DOI: https://doi.org/10.1002/cad.20037

Camacho, T. C., Roberts, R. E., Lazarus, N. B., Kaplan, G. A., & **Cohen, R. D.** (1991). Physical activity and depression: evidence from the Alameda County Study. *American Journal Epidemiology*, *134*(2), 220–231. DOI: https://doi.org/10.1093/oxfordjournals.aje.a116074

Chauloff, F. (1997). The serotonin hypothesis. *Physical activity and mental health*. Washington, DC: Taylor & Francis.

Collishaw, S., Maughan, B., Natarajan, L., & **Pickles, A.** (2010). Trends in adolescent emotional problems in England: a comparison of two national cohorts twenty years apart. *Journal of Child Psychology and Psychiatry*, *51*, 885–894. DOI: https://doi.org/10.1111/j.1469-7610.2010.02252.x

de Oliveira, G. D., Oancea, S. C., Nucci, L. B., & **Holm, N.** (2018). The association between physical activity and depression among individuals residing in Brazil. *Social Psychiatry Psychiatric Epidemiology*, *53*, 373–383. DOI: https://doi.org/10.1007/s00127-017-1441-6

Dishman, R. (1997). The norepinephrine hypothesis. *Physical activity and mental health*. Washington, DC: Taylor & Francis.

Farmer, M. E., Locker, B. Z., Moscicki, E. K., Dannenberg, A. L., Larson, D. B., & **Radloff, L. S.** (1998). Physical activity and depressive symptoms: the NHANESI epidemiologic follow-up study. *American Journal Epidemiololy*, *128*(6), 1340–1351. DOI: https://doi.org/10.1093/oxfordjournals.aje.a115087

Fløtnes, I. S., Nilsen, T. I. L., & **Augestad, L. B.** (2011). Norwegian adolescents, physical activity and mental health: The Young-HUNT study. *Norsk Epidemiologi*, *20*(2), 153–161. DOI: https://doi.org/10.5324/nje.v20i2.1336

Fredricks, J. A., & **Eccles, J. S.** (2006). Is extracurricular participation associated with beneficial outcomes? Concurrent and longitudinal relations. *Developmental Psychology*, *42*, 698–713. DOI: https://doi.org/10.1037/0012-1649.42.4.698

Greist, J. H., Morgan, W. P., & **Goldston, S. E.** (1987). Exercise intervention with depressed outpatients. *Exercise and mental health*.

Guddal, M. H., Stensland, S. Ø., Småstuen, M. C., Johnsen, M. B., Zwart, J. A., & **Storheim, K.** (2017). Physical Activity Level and Sport Participation in Relation to Musculoskeletal Pain in a Population-Based Study of Adolescents. The Young-HUNT Study. *The Orthopaedic Journal of Sports Medicine*, *5*(1). DOI: https://doi.org/10.1177/2325967116685543

Hoffman, P. (1997). The endorphin hypothesis. *Physical activity and mental health*. Washington, DC: Taylor & Francis.

Hume, C., Timperio, A., Veitch, J., Salmon, J., Crawford, D., & **Ball, K.** (2011). Physical activity, sedentary behavior, and depressive symptoms among adolescents. *Journal of physical activity and health*, *8*(2), 152–156. DOI: https://doi.org/10.1123/jpah.8.2.152

Hughes, J. R., Casal, D. C., & **Leon, A. S.** (1986). Psychological effects of exercise: A randomized cross-over trial. *Journal of Psychosomatic Research*, *30*(3), 355–360. DOI: https://doi.org/10.1016/0022-3999(86)90013-9

Jaakkola, T., Yli-Piipari, S., Barkoukis, V., & **Liukkonen, J.** (2017). Relationships among perceived motivational climate, motivational regulations, enjoyment, and PA participation among Finnish physical education students, *International Journal of Sport and Exercise Psychology*, *15*(3), 273–290. DOI: https://doi.org/10.1080/1612197X.2015.1100209

Jung, S., Lee, S., Lee, S., Bae, S., Imaoka, M., Harada, K., & **Shimada, H.** (2018). Relationship between physical activity levels and depressive symptoms in community-dwelling older Japanese adults. *Geriatrics Gerontology International*, *18*(3), 421–27. DOI: https://doi.org/10.1111/ggi.13195

Kalajas-Tilga, H., Hein, V., Koka, A., Tilga, H., Raudsepp, L., & **Hagger, M. S.** (2022). Application of the trans-contextual model to predict change in leisure time physical activity. *Psychology & Health*, *37*(1), 62–68. DOI: https://doi.org/10.1080/08870446.2020.1869741

Kalajas-Tilga, H., Koka, A., Hein, V., Tilga, H., & **Raudsepp, L.** (2020). Motivational processes in physical education and objectively measured physical activity among adolescents. *Journal of Sport and Health Science*, *37*(1), 462–471. DOI: https://doi.org/10.1016/j.jshs.2019.06.001

Kleppang, A. L., Hartz, I., Thurston, M., & **Hagquist, C.** (2018). The association between physical activity and symptoms of depression in different context – a cross-sectional study of Norwegian adolescents. *BMC Public Health*, *18*(1), 1368. DOI: https://doi.org/10.1186/s12889-018-6257-0

Koenig, L., Isaacs, A. M., & **Schwartz, J. A. J.** (1994). Sex differences in adolescent depression and loneliness: why are boys lonelier if girls are more depressed? *Journal of Research in Personality*, *28*, 27–43. DOI: https://doi.org/10.1006/jrpe.1994.1004

Lindegård, A., Jonsdottir, I. H., Börjesson, M., Lindwall, M., & **Gerber, M.** (2015). Changes in mental health in compliers and non-compliers with physical activity recommendations in patients with stress-related exhaustion. *BMC Psychiatry*, *15*, 272. DOI: https://doi.org/10.1186/s12888-015-0642-3

Liu, Y., Ozodiegwu, I. D., Yu, Y., Hess, R., & **Bie, R.** (2017). An association of health behaviors with depression and metabolic risks: data from 2007 to 2014 U.S. National Health and Nutrition Examination Survey. *Journal of Affective Disorders*, *217*, 190–196. DOI: https://doi.org/10.1016/j.jad.2017.04.009

Ma, L., Hagquist, C., & **Kleppang, A. L.** (2020). Leisure time physical activity and depressive symptoms among adolescents in Sweden. *BMC Public Health*, *20*, 997. DOI: https://doi.org/10.1186/s12889-020-09022-8

Mahoney, J. L., Schweder, A. E., & **Stattin, H.** (2002). Structured after-school activities as a moderator of depressed mood for adolescents with detached relations to their parents. *Journal of Community Psychology*, *30*, 69–86. DOI: https://doi.org/10.1002/jcop.1051

Martinsen, E. W. (2000). Fysisk aktivitet for sinnets helse. *Tidsskrift Den Norske Legeforeningen*, *120*, 3054–6.

McHale, S. M., Crouter, A. C., & **Tucker, C. J.** (2001). Free-time activities in middle childhood: Links with adjustment in early adolescence. *Child Development*, *72*, 1764–1778. DOI: https://doi.org/10.1111/1467-8624.00377

McMahon, E. M., Corcoran, P., O'Regan, G., Keeley, H., Cannon, M., Carli, V., Wasserman, C., Hadlaczky, G., Sarchiapone, M., Apter, A., Balazs, J., Balint, M., Bobes, J., Brunner, R., Cozman, D., Haring, C., Iosue, M., Kaess, M., Kahn, J., Nemes, B., Podlogar, T., Poštuvan, V., Sáiz, P., Sisask, M., Tubiana, A., Värnik, P., Hoven, C. W., & **Wasserman, D.** (2017). Physical activity in European adolescents and associations with anxiety, depression and well-being. *European Child & Adolescent Psychiatry*, *26*, 111–122. DOI: https://doi.org/10.1007/s00787-016-0875-9

Murphy, J., Sweeney, M. R., & **McGrane, B.** (2020). Physical Activity and Sports Participation in Irish Adolescents and Associations with Anxiety, Depression and Mental Wellbeing. Findings from the Physical Activity and Wellbeing (Paws) Study. *Physical Activity and Health*, 4(1), 107–119. DOI: https://doi.org/10.5334/paah.58

Norris, R., Carroll, D., & **Cochrane, R.** (1990). The effects of aerobic and anaerobic training on fitness, blood pressure, and psychological stress and well-being. *Journal of Psychosomatic Research*, *34*, 367–375. DOI: https://doi.org/10.1016/0022-3999(90)90060-H

Norris, R., Carroll, D., & **Cochrane, R.** (1992) The effects of physical activity and exercise training on psychological stress and well-being in an adolescent population. *Journal of Psychosomatic Research*, *36*, 55–65. DOI: https://doi.org/10.1016/0022-3999(92)90114-H

Norwegian Directorate of Health. (2019). Fysisk aktivitet for barn, unge, voksne, eldre og gravide. https://www.helsedirektoratet.no/faglige-rad/fysisk-aktivitet-for-barn-unge-voksne-eldre-og-gravide/fysisk-aktivitet-for-barn-og-unge

NTNU. (2019) Om HUNT. https://www.ntnu.no/hunt/om

Randall, E. T., & **Bohnert, A. M.** (2009). Organized Activity Involvement, Depressive Symptoms, and Social Adjustment in Adolescents: Ethnicity and Socioeconomic Status as Moderators. *Journal of Youth and Adolescence*, *38*, 1187–1198. DOI: https://doi.org/10.1007/s10964-009-9417-9

Rangul, V., Holmen, T. L., Bauman, A., Bratberg, G. H., Kurtze, N., & **Midthjell, K.** (2011). Factors Predicting Changes in Physical Activity Through Adolescence: The Young-HUNT Study, Norway. *Journal of Adolescent Health*, *48*, 616–624. DOI: https://doi.org/10.1016/j.jadohealth.2010.09.013

Rangul, V., Holmen, T. L., Kurtze, N., Cuypers, K., & **Midthjell, K.** (2008). Reliability and validity of two frequently used self-administered physical activity questionnaires in adolescents. *BMC Medical Research Methodology*. DOI: https://doi.org/10.1186/1471-2288-8-47

Simpkins, S. D., Fredricks, J. A., Davis-Kean, P. E., & **Eccles, J. S.** (2006). Healthy mind, healthy habits: The influence of activity involvement in middle childhood. *Developmental contexts in middle childhood: Bridges to adolescence and adulthood*, 283–302. DOI: https://doi.org/10.1017/CBO9780511499760.015

Singh, N., Clements, K. M., & **Fiatarone, M. A.** (1997). A Randomized Controlled Trial of Progressive Resistance Training in Depressed Elders. *Journal of Gerontology: MEDICAL SCIENCES*, *52A*(1), M27–M35. DOI: https://doi.org/10.1093/gerona/52A.1.M27

Singh, N. A., Stavrinos, T. M., Scarbek, Y., Galambos, G., Liber, C., & **Singh, M. A. F.** (2005). A Randomized Controlled Trial of High Versus Low Intensity Weight Training Versus General Practitioner Care for Clinical Depression in Older Adults. *Journal of Gerontology: MEDICAL SCIENCES*, *60A*(6), 768–776. DOI: https://doi.org/10.1093/gerona/60.6.768

Smit, F., Shields, L., & **Petrea, I.** (2016). Preventing depression in the WHO European Region. (WHORapport) http://www.euro.who.int/__data/assets/pdf_file/0003/325947/New-Preventing-depression.pdf?ua=1

Steene-Johannessen, J., Anderssen, S. A., Bratteteig, M., Dalhaug, E. M., Andersen, I. D., Andersen, O. K., Kolle, E., Ekelund, U., & **Dalene, K. E.** (2019). Kartlegging av fysisk aktivitet, sedat tid og fysisk form blant barn og unge 2018 (ungKan3).

Stephens, T. (1988). Physical activity and mental health in the United States and Canada: evidence from four population surveys. *Preventive Medicine*, *17*(1), 35–47. DOI: https://doi.org/10.1016/0091-7435(88)90070-9

Steptoe, A., & **Butler, N.** (1996). Sports participation and emotional wellbeing in adolecents. *The Lancet*, *347*. DOI: https://doi.org/10.1016/S0140-6736(96)91616-5

Strand, B. H., Dalgard, O. S., Tambs, K., & **Rognerud, M.** (2003). Measuring the mental health status of the Norwegian population: A comparison of the instruments SCL-25, SCL-10, SCL-5 and MHI-5 (SF-36). Nordic Journal of Psychiatry. DOI: https://doi.org/10.1080/08039480310000932

Stubbs, B., Koyanagi, A., Scuchu, F. B, Firth, J., Rosenbaum, S., Veronese, N., Solmi, M., Mugisha, J., & **Vancampfort, D.** (2016). Physical activity and depression: a large cross-sectional, population-based study across 36 low-and middle-income countries. *Acta Psychiatrica Scandinavica*, *134*(6), 546–556. DOI: https://doi.org/10.1111/acps.12654

Sweeting, H., West, P., Young, R., & **Der, G.** (2010). Can we explain increases in young people's psychological distress over time? *Social Science and Medicine*, *71*, 1819–1830. DOI: https://doi.org/10.1016/j.socscimed.2010.08.012

Tambs, K., & **Moum, T.** (1993). How well can a few questionnaire items indicate anxiety and depression? *Acta Psychiatr Scand*, *87*, 364–7. DOI: https://doi.org/10.1111/j.1600-0447.1993.tb03388.x

VanKim, N. A., & **Nelson, T. F.** (2012). Vigorous Physical Activity, Mental Health, Perceived Stress, and Socializing Among College Students. *The Science of Lifestyle Change*, *28*(1). DOI: https://doi.org/10.4278/ajhp.111101-QUAN-395

Von Soest, T., & **Wichstrøm, L.** (2013). Secular Trends in Depressive Symptoms Among Norwegian Adolescents from 1992 to 2010. *Journal of Abnormal Child Psychology*, *42*, 403–415. DOI: https://doi.org/10.1007/s10802-013-9785-1

Walderhaug, E. (2008). The effects of tryptophan depletion on impulsivity and mood in healthy men and women (Doctorate dissertation). University of Oslo.

Wiles, N. J., Haase, A. M., Lawlor, D. A., Ness, A., & **Lewis, G.** (2012). Physical activity and depression in adolescents: cross-sectional findings from the ALSPAC cohort. *Social Psychiatry and Psychiatric Epidemiol*, *47*(7), 1023–1033. DOI: https://doi.org/10.1007/s00127-011-0422-4

Østerås, B., Sigmundsson, H., & **Haga, M.** (2017). Physical Fitness Levels Do Not Affect Stress Levels in a Sample of Norwegian Adolescents. *Frontiers in Psychology*, *8*, 2176. DOI: https://doi.org/10.3389/fpsyg.2017.02176

TO CITE THIS ARTICLE:
Bjerkan, M., Rangul, V., Skjesol, K., & Ulstad, S. O. (2022). Physical Activity and Depression/Anxiety Symptoms in Adolescents – the Young-HUNT Study. *Physical Activity and Health*, 6(1), pp. 73–85. DOI: https://doi.org/10.5334/paah.185

Submitted: 27 April 2022
Accepted: 25 May 2022
Published: 06 June 2022