

Role of Physical Activity to Strengthen Mental Health among Youth

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Abstract

This study aimed to investigate the association between physical activity and the mental health of youth aged 18-24, with a focus on understanding whether physical activity could be an effective strategy for fostering resilience, mitigating depressive symptoms, and improving overall mental well-being. The primary research question guiding this inquiry is: To what extent does physical activity function as a protective element against the onset of mental health issues in young individuals? The study involved the recruitment of participants from schools and universities in the Northern region of the Netherlands across different educational levels. Regression analysis was used to assess depressive symptoms and well-being as predictors for the change in these measures after two months, using physical activity as moderator. The results demonstrated that there were no significant moderating effects. Furthermore, the study's findings revealed that physical activity did not significantly predict depressive symptoms or well-being outcomes in the examined sample. It is recommended that future research adopt a longitudinal approach with a longer timeframe and a more diverse sample to understand the effects in a better way. The findings of this study also hold implications for the development policy initiatives aimed at fostering a culture of physical activity and promoting mental well-being among youth, thus contributing to the advancement of both research and practice in the field of youth mental health promotion.

Keywords: *physical activity, mental health, depressive symptoms, and well-being.*

Dit onderzoek was gericht op het onderzoeken van het verband tussen lichaamsbeweging en de geestelijke gezondheid van jongeren in de leeftijd van 18-24 jaar, waarbij de nadruk lag op de vraag of lichaamsbeweging een effectieve strategie zou kunnen zijn voor het bevorderen van veerkracht, het verminderen van depressieve symptomen en het verbeteren van het algehele geestelijke welzijn. De primaire onderzoeksvraag die de leidraad vormt voor dit onderzoek is: In hoeverre werkt lichaamsbeweging als een beschermend element tegen het ontstaan van psychische problemen bij jonge mensen? Voor het onderzoek werden deelnemers van scholen en universiteiten in het noorden van Nederland van verschillende opleidingsniveaus gerekruteerd. Regressieanalyse werd gebruikt om depressieve symptomen en welzijn te beoordelen als voorspellers voor de verandering in deze maten na twee maanden, met lichaamsbeweging als moderator. De resultaten toonden aan dat er geen significante modererende effecten waren. Verder bleek uit de bevindingen van het onderzoek dat lichamelijke activiteit geen significante voorspeller was van depressieve symptomen of welzijn in de onderzochte steekproef. Er wordt aanbevolen om in toekomstig onderzoek een

longitudinale aanpak te hanteren met een langere tijdspanne en een meer diverse steekproef om de effecten beter te begrijpen. De bevindingen van dit onderzoek hebben ook gevolgen voor de ontwikkeling van beleidsinitiatieven gericht op het stimuleren van een cultuur van lichaamsbeweging en het bevorderen van mentaal welzijn onder jongeren, en dragen zo bij aan de vooruitgang van zowel onderzoek als praktijk op het gebied van de bevordering van de geestelijke gezondheid onder jongeren.

Trefwoorden: *lichamelijke activiteit, geestelijke gezondheid, depressieve symptomen en welbevinden*

Introduction

Recognizing mental health as essential to overall well-being reflects to the World Health Organization's (WHO) 1946 constitution, where it is defined as “a state of complete physical, mental and social well-being” (Conference, I. H., 2002). Addressing mental challenges is of particular importance during youth phase as it is a unique and developmental period for social and emotional development as it creates the foundation for long-term and intergenerational health and well-being (Konaszewski, K. et al., 2021). Strengthening youth’s internal and external resources and protecting them from risk factors such as depression and adverse experiences, can significantly enhance their prospects for thriving and mental well-being in adulthood. (Baltag, V., & Servili, C., 2016). The World Health Organization (WHO) reports that around 20% of adolescents and young adults struggle with mental health issues such as depression and anxiety, with approximately half of these conditions emerging by age 14 and three-quarters by the mid-20s (WHO, 2021).

Mental health issues, especially depressive symptoms, are a major concern in contemporary society due to their profound effect on overall well-being, impacting people of all ages, genders, and socioeconomic statuses (Deverill, C & King, M., 2009). Depression is marked by persistent sadness and a lack of interest which in-turn severely affects well-being (American Psychiatric Association, 2013). Typical symptoms include disturbances in sleep and appetite, fatigue, and difficulty concentrating (American Psychiatric Association, 2013). It is a significant contributor to the global disease burden affecting over 12% of youth experiencing depressive symptoms (Baltag, V., & Servili, C., 2016). These depressive symptoms can greatly reduce the well-being of young people. Addressing youth mental health is not only a public health priority but also a critical investment in the future of society. By fostering supportive environments and providing access to mental health resources, we

can enhance the resilience and potential of young people, ultimately contributing to a healthier and productive society.

Impact of Physical Activity on Depressive Symptoms

Depressive symptoms that persist for longer than two weeks can be diagnosed as depression, which is a prevalent mental health condition as identified by Deverill & King (2009). It manifests through symptoms such as persistent low mood and disinterest in daily activities (NICE, 2009). Given the high prevalence of mental health problems among youth, understanding what factors could boost the mental health of youth is crucial. A seemingly important factor that has the potential to boost youth's mental health is physical activity (Craft, L. L. 2005). Correlation studies on the relationship between physical activity and depressive symptoms are inconsistent. Only a limited number of studies have investigated potential mediators elucidating how and why physical activity might alleviate depression in youth (Craft, 2005; McPhie & Rawana, 2012; Petty et al., 2009; Kendrick & Yardley, 2009), leaving a gap in understanding the mechanisms underlying these beneficial effects.

The impact of physical activity on reducing depressive symptoms can be understood through various theoretical frameworks, highlighting its multifaceted benefits on mental health. According to the biopsychosocial model, physical activity is believed to boost mental health by enhancing physical well-being, improving mood through the release of endorphins, and providing opportunities for social interaction and achievement (Engel, 1977). Furthermore, the neurogenesis hypothesis suggests that physical activity can promote the growth of new neurons, particularly in the hippocampus, which is associated with mood regulation which thereby aids in reducing depressive symptoms (Erickson et al., 2011). These theoretical perspectives underscore the comprehensive advantages of physical activity, making it a crucial component for enhancing overall mental health.

Youth that experience depressive symptoms are physical less active and exhibit a poorer physical condition compared to non-depressed counterparts (Paluska & Schwenk, 2000). Brunet et al. conducted a cross-sectional study revealing that individuals who engage in regular physical activity tend to experience fewer symptoms of depression and anxiety. Similarly, Song et al. conducted a cross-sectional and descriptive study indicating that youth with depression spend less time engaging in mild and moderate physical activity compared to those without depression. Although there is consistent evidence that physical activity correlates with depression (Rimer et al., 2012), the specific mechanisms by which physical

activity reduces depressive symptoms are not yet clear. Moreover, research conducted during the COVID-19 pandemic has highlighted that physical inactivity worsens the symptoms of depression (Meyer et al., 2020). Higher levels of physical activity and participation in sports are linked to lower levels of depressive symptoms (Hallal et al., 2006; Sund et al., 2011). Most importantly, when inactive depressed youth become more physically active their mood enhances (Ströhle, 2009; Pasco et al., 2011; Dinas et al., 2011), suggesting a causal relationship between physical activity and mental health.

Conflicting findings exist, as the relationship between physical activity and mental health is often characterized as weak to moderate. (Biddle & Asare, 2011; Larun et al., 2006), and some studies also report no association between depressive symptoms and physical activity (De Moor et al., 2008; Rethon et al., 2010). Together, these studies thus suggest that physical activity might buffer depressive symptoms and improve youth's overall mental health but more longitudinal research is needed to confirm this. A meta-analysis conducted by Schuch et al. (2018), encompassing 49 prospective studies with a total sample of 266,939 individuals, revealed that higher levels of physical activity were associated with reduced odds of developing depression. This inconsistency highlights the need for more comprehensive and systematic studies to clarify to resolve existing inconsistencies, understand underlying mechanisms, develop effective interventions, and ultimately improve mental health outcomes on a broad scale.

Impact of Physical Activity on Well-Being

Research involving general population and healthy samples has revealed associations between physical activity and mental health benefits (Teychenne et al., 2008). The relationship between physical activity and mental well-being among youth requires significant attention in psychological and educational research. According to the self-determination theory, physical activity is believed to enhance well-being by fulfilling basic psychological needs such as competence, autonomy, and relatedness (Deci & Ryan, 2000). Additionally, the social-ecological model shows that physical activity can improve well-being by providing opportunities for social interaction, developing motor skills, and fostering a sense of achievement (Stokols, 1992).

Engaging in regular physical activity appears to provide positive psychosocial outcomes such as improved mood, increased self-esteem, reduced anxiety, and enhanced social interactions (Biddle & Asare, 2011). Research indicates that physical activity can

stimulate the release of endorphins and other neurotransmitters, which contribute to a heightened sense of well-being and reduced stress levels (Biddle, 2006). Additionally, participating in physical activities can offer structured routines and goals, fostering a sense of accomplishment and competence, which are crucial for building self-esteem (Fox, 1999). Youth who are actively involved in such activities tend to report improved mental well-being compared to their inactive counterparts (Hjemdal et al., 2006). Regular physical activity is associated with better emotional regulation and social functioning in young people, providing them with opportunities for social engagement and support, which are essential for emotional resilience (Lubans et al., 2012). Moreover, physical activity has been linked to improved academic performance, likely due to enhanced cognitive function and concentration (Singh et al., 2012), further contributing to the overall mental well-being of youth.

Researchers have explained the impact of physical activity on well-being through various theoretical frameworks, highlighting its multifaceted benefits on youth's mental health. According to self-determination theory, physical activity can enhance individuals' feelings of competence, autonomy, and relatedness to others (Deci & Ryan, 2000). This theory suggests that when individuals engage in physical activity, they often experience a sense of mastery and skill development (competence), have control over their actions and decisions (autonomy), and connect with others through social interactions (relatedness). Faulkner & Carless (2006) highlighted that these psychological needs are essential for fostering intrinsic motivation and overall well-being. When these needs are satisfied, individuals are more likely to experience positive mental health outcomes, such as reduced anxiety and depression. Physical activity can provide a valuable distraction from negative thoughts which are often associated with depression and anxiety. Craft (2005) argues that engaging in physical exercise diverts attention away from worries and stressors, allowing individuals to focus on their day-to-day activities. This temporary relief from negative thinking can provide mental clarity and emotional relief. These theoretical perspectives emphasize the broad benefits of physical activity, underscoring its importance as a vital component for improving overall well-being.

However, studies examining the role of physical activity in promoting well-being among youth are often correlational (Biddle & Asare, 2011; Janssen & LeBlanc, 2010) and cross-sectional (Eime et al., 2013), making it challenging to draw conclusions on its causality. These studies generally find an association between physical activity and improved well-being, but they do not definitively demonstrate that physical activity causes these

enhancements. Moreover, the findings regarding the impact of physical activity on well-being in youth are inconsistent. Meta-analyses and systematic reviews provide mixed results, with some reporting significant positive effects of physical activity on various aspects of well-being, including emotional, psychological, and social well-being (Lubans et al., 2016), while others note only modest benefits or highlight methodological limitations such as small sample sizes, variability in the measurement of physical activity and well-being, and the lack of longitudinal data (Biddle et al., 2019; Rodriguez-Ayllon et al., 2019).

The role of physical activity in relation to mental health is increasingly recognized as a critical area of study as it represents a significant factor that requires attention in the context of mental health. Previous literature indicates that the relationship between physical activity and mental health outcomes in young people is complex. Nevertheless, there remain significant gaps in the existing literature with regard to potential moderator effects between these variables.

The research question guiding the study is, ‘To what extent does physical activity function as a protective element against the onset of mental health issues in young individuals?’ The present study aims to examine the relationship between physical activity and mental health of youth aged 18-24 with the goal of preventing depressive symptoms, and enhancing overall mental well-being in youth. A moderation analysis will be performed to understand the changes in depressive symptoms and well-being. The study aims to assess depressive symptoms and well-being at t0 (at baseline) as predictors for the change in these measures at t2 (after two months), using physical activity at t1 as moderator. This approach will provide insights into whether the initial level of depressive symptoms can predict changes in these symptoms and well-being over time. Based on existing literature, the following hypotheses are proposed:

Hypothesis 1: Physical activity has a positive impact on subsequent mental health of youth, as it decreases the severity of depressive symptoms (H1a) and increases well-being one month later (H1b).

Hypothesis 2 (H2): The change in depression severity from t0 to t2 is moderated by the level of physical activity at t1. Specifically, higher levels of physical activity at t1 are associated with a greater reduction in depression severity from t0 to t2.

Hypothesis 3 (H3): The change in well-being from t0 to t2 is moderated by the level of physical activity at t1. Specifically, higher levels of physical activity at t1 are associated with improved well-being from t0 to t2.

Methodology

Design and Sample Description:

The data for the present study is a subsample of the ‘No Fun No Glory’ (NFNG) study (for more information, please see: van Roekel et al., 2017). The study has a longitudinal research design, and for this study the data from the baseline questionnaire (t0) as well as the monthly questionnaires were used (t1 and t2). The sub-sample consists of 138 young adults aged 18 to 24 years from the Northern part of the Netherlands (78% women, $M_{age} = 21.4$).

The NFNG randomized controlled study is registered in the Dutch Clinical Trial Register (NTR5498), was approved by the Dutch Central Medical Ethics Committee from the University Medical Centre Groningen (no. 2014/508), and is described in more detail by van Roekel et al. (2016).

Procedure:

Participants were recruited in the Northern part of the Netherlands through flyers, electronic learning environments, advertisements on social media, and invitations during lectures and classes. Invitations to subscribe were distributed via email, electronic learning environments, flyers, social media, and oral presentations during classes and lectures. Participants could subscribe online (www.nofunnoglory.nl). After subscription, participants automatically received a link to the survey. In addition to administration via the website, the survey was administered in classes during school hours. The classroom sessions were supervised by a research assistant who could answer queries, if necessary. The participants received a gift card worth ten euros and had the chance to win further prizes, including fashion vouchers, tablets, and a 4-city trip through a raffle after completion of the questionnaire.

Variables and Instruments:

Depressive Symptoms: Depressive symptoms were measured using the Patient Health Questionnaire (PHQ; Kroene et al., 2001). The PHQ consists of nine items measuring

depressive symptom severity over the last two weeks. Participants respond on a four-point Likert scale, ranging from 0 (not at all) to 3 (nearly every day). An example of an item is ‘In the past 2 weeks, how often have you suffered from Little interest or pleasure in activities?’. The mean scores of all nine items calculated, such that a higher score indicates more depressive symptoms. Cronbach's Alpha for the PHQ were $\alpha = 0.87$ at t0, $\alpha = 0.86$ at t1, and $\alpha = 0.83$ at t2.

Well-Being: Well-being was measured using Domains of Pleasure Scale (DOPS, van Roekel et al., 2017) at t0 and t2. Wellbeing was calculated as the mean score of nine items (e.g., ‘I enjoy being with family or close friends’), such that a higher score indicated a higher level of well-being. Participants respond on a continuous scale, ranging from 0 (not at all) to 100 (very much). Cronbach's Alpha for the DOPS were $\alpha = 0.90$ at t0, $\alpha = 0.86$ at t1, and $\alpha = 0.83$ at t2.

Physical Activity: Physical activity was measured using one item of The Tracking Adolescents’ Individual Lives Survey (TRAILS); (Ormel et al., 2012), administered at baseline (t0) as well as one month (t1) and two months (t2). The question was ‘how many days in the most recent normal week did you spend at least 60 minutes a day doing physical activity?’ to which participants could answer with 0 (not at all) to 7 (every day). The participants were instructed that physical activity meant activities that make the heart beat faster and sometimes make you run out of breath, such as exercising, walking or biking to school or work, etc. The question was asked over the most recent normal week. A higher score indicates higher frequency of physical activity over the last week.

Analytical Strategy:

After calculating the descriptive statistics such as mean, median, mode, range, standard deviation, frequency distribution and correlations, the data was analysed using the IBM SPSS Statistics Version 28. Assumption testing involved checking for normality, homoscedasticity, and linearity in regression analyses. If the assumptions were not met, we considered appropriate alternative methods or transformations, and provide the rationale for these decisions.

For the 1st hypothesis where physical activity has a positive impact on subsequent mental health of youth, as it decreases the severity of depressive symptoms and improves well-being, a multivariate regression analysis was conducted with PHQ and DOPS scores at t2 as the dependent variables and TRAILS Physical Activity at t1 as the independent variable.

PHQ and DOPS scores at t2 were chosen to understand the impact of physical activity allowing us to observe changes in mental health one month thereby providing a clear assessment period and aligning with existing literature on the delayed effects of physical activity on mental health.

With respect to the 2nd and 3rd hypotheses, which states that physical activity is the moderator of change in depressive symptoms and wellbeing over time, two separate linear regression analyses were performed with depressive symptoms and wellbeing measured at t0 and t2, serving as the dependent variables. The implementation of separate linear regression analyses for each outcome variable at different time points (t1 and t2) would allow us to examine the moderating role of physical activity. By analysing the associations between physical activity and depressive symptoms, as well as wellbeing, independently for each time point, it is possible to identify potential changes or stability in these relationships over time.

Results

Descriptive statistics

From 138 participants, only 116 (84.1%) participants had complete data on all variables and were included for the analysis. As depicted in Table 1, the mean age of the participants were 21.65 years (SD= 1.90). On average, participants had a depression score of 7.38 (SD=5.42) at baseline (t0) and 6.11(SD=4.16) after two months (t2). On the other hand, participants had a mean well-being score of 71.38 (SD=11.36) at the baseline (t0) and 64.93 (SD=12.13) after two months (t2).

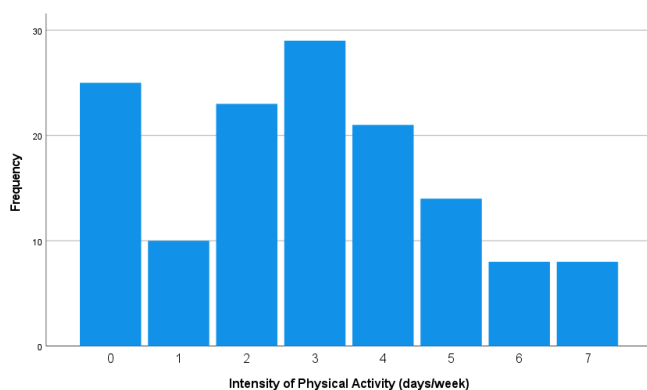
The correlation analysis showed a significant and positive correlations between physical activity and well-being after one month ($r= 0.19^*$, $p= 0.017$), as well as between physical activity and well-being after two months ($r= 0.212^*$, $p= 0.017$), indicating that higher levels of physical activity are associated with higher levels of future well-being. There was no correlation between participant's physical activity and their levels of depression after one month nor two months (see table 1).

As shown in Figure 1, majority of the participants were moderately physically active (level 3; 21%), followed by 18.1% of participants with no physical activity and 5.8% of participants with high level of physical activity (level 6 and 7).

Table 1*Descriptive Statistics*

	Mean	SD	Pearson's Correlation							
			1	2	3	4	5	6	7	
1. Age	21.65	1.90	1							
2. Sex	1.78	0.41	-0.08	1						
3. Depression t0	7.38	5.42	0.00	-0.09	1					
4. Depression t2	6.11	4.16	0.05	-0.02	0.77**	1				
5. Well-being t0	71.38	11.36	-0.08	-0.02	-0.49**	-0.40**	1			
6. Well-being t2	64.93	12.13	-0.08	-0.07	-0.3**	-0.39**	0.67**	1		
7. Physical Activity at t1	2.95	1.97	-0.01	-0.02	-0.04	0.02	0.19*	0.21*	1	

Note. ** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level

Figure 1*Frequency of Physical Activity Levels*

Hypothesis 1: Effect of physical activity on mental health (i.e., depressive symptoms, H1a, and well-being, H1b)

In Table 2, physical activity was found to be a significant predictor of well-being two months later, as evidenced by its coefficient of 1.271 ($p= 0.017$). This suggests that for every unit increase in physical activity, there is a corresponding increase of 1.271 units in well-being, highlighting a positive influence of physical activity on overall well-being.

Physical activity did not emerge as a significant predictor of depression after two months. This means that physical activity levels did not significantly contribute to variations in depression scores two months later.

Table 2

Parameter Estimates of Physical Activity on Depression and Well-Being

Dependent variable two months later (t2)	Parameter	B	Std. Error	t	p-value	95% Confidence Intervals	
						Lower Bound	Upper Bound
Depression	Intercept	5.904	0.659	8.965	<0.001	4.601	7.208
	Physical Activity	0.059	0.189	0.310	0.757	-0.315	0.433
Well-being	Intercept	61.547	1.837	33.506	<0.001	57.911	65.183
	Physical Activity	1.271	0.527	2.411	0.017	0.228	2.314

Note: Physical activity was measured at t1

Hypothesis 2: Physical activity as the moderator of change in depressive symptoms

The results from Table 3 indicate that there is a significant main effect of depressive symptoms at baseline (t0) on depressive symptoms two months later (t2), meaning that individuals who exhibited higher levels of depressive symptoms at baseline were more likely to continue experiencing higher levels of depressive symptoms after two months. However, after controlling for baseline depressive symptoms, participant's level physical activity did not significantly predict the level of depressive symptoms two months later nor the changes

in depressive symptoms over the next two months. The change in depression severity from t0 to t2 was thus not significantly moderated by the level of physical activity at t1.

Table 3:

Regression analysis with Depression at t2 as the dependent variable

	Unstandardised		Standardised	<i>t</i>	p-value
	Coefficients		Coefficient		
	B	Std. Error	Beta		
(Constant)	1.423	0.680		2.094	0.038
Baseline Depression	-0.411	0.068	-0.651	-6.012	<0.001
Physical Activity	0.026	0.198	0.016	0.134	0.894
PAXDepression	0.012	0.021	0.085	0.604	0.547

Note: B= coefficient estimates, t= t-value, Std Error= standard error, PAXDepression= interaction effect between physical activity and baseline depression

Hypothesis 3: Physical activity as the moderator of change in well-being

The results from Table 4 indicate that the physical activity at t1 significantly predicted change in well-being at t2 with a coefficient of -5.922 ($p = 0.02$), indicating that higher levels of physical activity are associated decrease in well-being two months later. Importantly, the interaction between baseline well-being levels and physical activity at t1 was significant with coefficient of 0.09 ($p = 0.016$) meaning that for each unit that participants are more physically active, their well-being is 0.09 units higher two months later.

Table 4*Regression analysis with Well-being at t2 as the dependent variable*

	Unstandardised		Standardised	<i>t</i>	p-value
	Coefficients		Coefficient		
	B	Std. Error	Beta		
(Constant)	27.572	7.819		3.526	<0.001
Baseline Well-being	-0.502	0.113	-0.599	-4.452	<0.001
Physical Activity	-5.922	2.613	-1.231	-2.266	0.025
PAxWell-being	0.090	0.037	1.398	2.446	0.016

Note: B= coefficient estimates, t= t-value, Std Error= standard error, PAxWell-being= interaction effect between physical activity and baseline well-being

Discussion

The primary aim of this research study was to investigate the association between physical activity and mental health of youth with a focus on understanding whether physical activity can help reduce depressive symptoms and improve overall well-being. Similar to the positive correlation between physical activity and well-being ($r = 0.212$, $p = 0.017$), regression analyses showed that the physical activity at t1 significantly predicted change in well-being at t2 with a coefficient of -5.922 ($p = 0.02$). Moreover, the interaction between baseline well-being levels and physical activity at t1 was significant with coefficient of 0.09 ($p = 0.016$) meaning that participants who engaged in more physically active, experienced higher well-being two months later.

Regarding the descriptive statistics, the average level of physical activity in the present study appeared to be notably lower compared to national and international studies. That is, we found that 21% of participants were not engaged in any form of physical activity, with only 5.8% participating in high-intensity physical activity. Based on WHO data, globally, in 2016, 23% of men and 32% of women aged 18 years and above were classified as insufficiently physically active. Two studies conducted in Turkey, focusing on different age

groups, revealed a prevalence of insufficient physical activity at 16.4% and 14.8%, respectively (Aktas et al., 2015; Isin & Ozcan, 2018).

Partly in the line with our first hypothesis, our results showed that physical activity positively impacts well-being one month later (H1a) but not depressive symptoms one month later (H1b). Similarly, over two months, contrary to our second hypothesis (H2) but in line with our third hypothesis (H3), our results showed that more physical activity was associated with an increase in well-being over two months but not with a decrease in depressive symptoms.

The finding of a positive effect of physical activity on well-being (H1a), and on the change in well-being over two months (H3) finding is consistent with existing literature (Rebar et al., 2015; Schuch et al., 2018). Rebar et al. (2015) conducted a meta-analysis of 33 studies over various durations, ranging from a few weeks to several months, and found that regular physical activity significantly improved overall well-being. Schuch et al. (2018) carried out a systematic review and meta-analysis focusing on individuals with depression, examining studies within the timeframe of from 4 weeks to 12 months. They concluded that physical activity had a robust positive impact on both mental health and well-being. These studies collectively reinforce the idea that engaging in regular physical activity can lead to sustained improvements in well-being over time. Another study has demonstrated the beneficial effects of regular physical activity on reducing depressive symptoms and improving overall psychological functioning on a shorter time frame (Craft & Perna, 2004).

Similarly, a longitudinal study by Kandola et al. (2019) examined the association between physical activity and mental well-being over time. They found that individuals who engaged in regular physical activity experienced improvements in mental well-being over a period of two years, compared to those who were less active. This study underscores the importance of sustained physical activity in promoting long-term mental well-being. Further support for the link between physical activity and well-being comes from a randomized controlled trial by Netz et al. (2013). Their study demonstrated that participation in a structured physical activity program which was conducted over a period of six months led to significant improvements in various aspects of well-being, including mood, self-esteem, and overall life satisfaction, compared to a control group.

We were the first to find these effects over a two month's time frame which underscores the importance of sustained physical activity for long-term improvements in

well-being. Our study found that the effect size for H3, which examined the change in well-being over two months, was small. It is important to consider whether such a small change can meaningfully impact an individual's well-being in everyday life. Although the statistical significance indicates a reliable effect, the practical implications might be limited. This finding suggests that while sustained physical activity does contribute to improved well-being, the magnitude of its impact over two months might not be as pronounced as shorter interventions. Future research could explore whether longer durations or more intensive physical activity regimens might provide more substantial improvements, thereby providing clearer guidance for clinical practice and public health recommendations.

Several factors could explain the lack of association that we did not find physical activity to be a significant predictor of depressive symptoms one month later (H1b) and across two months (H2). Firstly, prior research that found an association between physical activity and decreased depressive symptoms (Craft & Perna, 2004; Kvam et al., 2016) used a considerably longer timeframe. Our study might have been too short to be able to observe the significant impact of physical activity on depressive symptoms. Indeed, changes in depressive symptoms might require a longer duration to manifest significantly. For example, a study showed a positive correlation involved an intervention period of one year, suggesting that a two-month period might be too brief to capture the full benefits of physical activity on depression (Rethorst et al., 2009).

Secondly, the way we measured physical activity could also explain why we did not find a significant impact whereas others did. Factors such as the intensity and type of physical activity, participants' baseline physical health, lifestyle factors, and environmental stressors might have influenced the outcomes (Biddle & Asare, 2011; Schuch et al., 2016). Additionally, psychosocial variables such as social support, stress levels, and sleep quality were not controlled in our study but are known to interact with both physical activity and mental health (Hamer et al., 2009). Another possibility is the measurement and self-reporting accuracy of physical activity and depressive symptoms. Self-reported data can be subject to biases such as social desirability or recall bias, which might have affected the reliability of the reported physical activity levels and depressive symptoms (Prince et al., 2008).

Furthermore, some studies indicate that high intensity of physical activity can temporarily alleviate depressive symptoms, but these effects may not necessarily accumulate over months without consistent and progressively challenging physical activity regimens

(Kvam et al., 2016). Our findings align with some previous studies that have also failed to find a moderating effect of physical activity on changes in depression severity over time (Mammen & Faulkner, 2013; Sallis et al., 2020). The study by Mammen & Faulkner (2013) was conducted over a 12-week period, while Sallis et al. (2020) examined changes over a span of six months. Both studies suggest that the time frame might not be sufficient to detect a moderating effect of physical activity on depression severity. These results challenge the notion that physical activity alone can mitigate the progression of depressive symptoms, highlighting the complexity of factors influencing mental health outcomes. Likewise, in another study, a negative correlation was observed between levels of physical activity and levels of depression (Rethorst, C. D., et al., 2009). The study revealed that increase in physical activity, even at low intensity, provided beneficial effects on mental health, with predominantly inactive individuals exhibiting more symptoms of depression and anxiety.

Future researchers that are interested in the long-term effects of physical activity on depressive symptoms should aim to use more robust and objective measures for physical activity such as wearable fitness trackers or heart rate monitors. These tools provide accurate, continuous data on various aspects of physical activity, including intensity, duration, and frequency, that could enhance the accuracy and reliability of the results (Haskell et al., 2007; Hamilton et al., 2007).

Conclusion

In conclusion, being more physically active does not make youth more resilient to depressive symptoms over the next two months but might slightly increase their well-being. We have observed that engaging in regular physical activity is associated with a noticeable improvement in overall well-being. Although the activity did not significantly boost resilience to depressive symptoms within the two-month period, it did foster a more positive state of mind, suggesting that even moderate increases in activity levels can lead to emotional benefits. These benefits, observed even up to two months after increased physical activity, suggest that incorporating regular exercise into daily routines can be a practical and accessible strategy for promoting mental health and well-being among young people.

It is crucial for policymakers, educators, and healthcare professionals to collaborate in integrating physical activity promotion into comprehensive strategies for mental health promotion and prevention. Through these efforts, we can strive to cultivate a healthier and more resilient youth population, thereby enhancing the overall well-being of society.

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Assessment John Exalto:

This thesis, which examines the relationship between physical activity and the mental health of youth aged 18-24, is a valuable contribution to research on this topic. The study is well-designed and executed, with the methodology and theoretical framework clearly outlined.

There are three aspects I would like to comment on. First, the Dutch summary is careless.

Second, the terms 'youth' and 'young adults' are used interchangeably, making it unclear how these categories relate to the 18-24 age group. This age group is also not problematized, which would have been important in the context of the research.

Third and finally, the conclusion does not show a direct correlation between physical activity and resilience against depression. The student attributes this to the two months during which the study was conducted. She could have gone a step further by problematizing and discussing this relationship itself, but she does not do this; instead, she integrates her conclusion into the existing literature. These three aspects merit further investigation. In the meantime, the student has successfully completed her studies with this thesis.

John Exalto

June 6th, 2024

Assessment Vera Heininga:

The focus and grounding of this thesis are meticulously developed, offering valuable insights into the intricate relationship between physical activity and mental health. The thesis demonstrates potential for contributing to our understanding, particularly regarding the moderating effects of physical activity on changes in youth mental health (or at least the wellbeing component of mental health considering the results). The longitudinal design with repeated measurements, the use of moderated linear regression analysis, and the application of validated instruments are significant strengths of this thesis. However, there are several areas where improvements could be made.

First, the structure and flow of the introduction could be optimized. Currently, the problem definition lacks clarity, which affects the overall coherence of the section. Second, the thesis impressively employs complex statistical analyses, especially concerning changes in depression severity and wellbeing (H2 and H3). The examination of the moderating effect of physical activity on mental health changes at T2, controlling for baseline levels (T0), is noteworthy. However, the descriptions of these analyses are occasionally inaccurate, notably in the abstract and analytical strategy sections. Furthermore, despite mentioning assumption checks in the methods section, there is a lack of references to these checks in the appendices. Third, the discussion section's structure and flow remain still a bit suboptimal. For instance, starting the discussion of results with descriptive statistics rather than the main findings (i.e., results for each hypothesis) is confusing. Additionally, the results for H1, which indicate the significant effect of physical activity on wellbeing, are not highlighted as a main finding.

Shayana demonstrated exceptional commitment and punctuality, consistently submitting parts of her thesis on time. She exhibited a high degree of independence in her work. While she effectively incorporated most feedback from me as her thesis supervisor, there were some areas for improvement concerning the suggestions made in the last draft (e.g., particularly in trial registration and variable naming in the methods section, as well as not starting with descriptives in the discussion section). Nonetheless, her overall ability to adapt her thesis

based on feedback throughout the half year in which the thesis was written was commendable. Additionally, she managed data with excellent care and adhered to ethical standards.

Vera Heininga

June 6th, 2024