PAAH
PHYSICAL ACTIVITY AND HEALTH

The Association between Physical Activity and Mental Health among Danish Women Aged 16–34 Years

RESEARCH

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ABSTRACT

Poor mental health among young Danish women (16–34 years) constitutes a public health problem. Literature shows a positive association between physical activity and mental health, but knowledge about the association among young Danish women is missing.

Aim: To investigate whether physical activity is associated with higher odds for mental health among Danish women aged 16–34 years and to investigate the significance of the duration of physical activity.

Methods: This cross-sectional study included 756 16–34-year-old women from the national survey Sports participation among the Danes 2020. Physical activity was measured as the total number of minutes/week spent on sports/exercise. Women were categorised as inadequately and adequately physically active with a cut-off at 210 minutes/week. Mental health was measured through the WHO-5 Well-Being Index. Logistic regressions were performed followed by Wald tests. Further, a linear regression was performed followed by a t-test.

Results: Inadequately physically active women had 38% lower odds for high mental health (OR 0.62 (CI 0.43; 0.87)). This was statistically significant. The significance of the duration of physical activity showed a statistically significant association with a coefficient of 0.013 (CI 0.007; 0.019).

Conclusion: There was a statistically significant association between physical activity and mental health among Danish women aged 16–34 years. Further, there was a statistically significant dose-response association between the duration of physical activity and mental health.

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INTRODUCTION

In Denmark, mental health (MH) is decreasing in the population and especially among young women (Danish Health Authorities, 2018; Jensen et al., 2022). It has several consequences for both society and the individual. Every year poor MH causes 2.1 million extra days of long-term sick leave, 2,400 extra deaths, and 6,000 disability-adjusted life years. Additionally, poor MH is associated with increased contact with the healthcare system. In Denmark alone it is estimated that 1.1 million extra contacts to the doctor happen among people with poor MH, 51,500 extra hospitalisations every year, and 660,000 extra yearly ambulatory hospital visits among people with poor MH. Moreover, the municipalities co-finance 3.5 billion DKK every year linked to poor MH (Danish Health Authorities, 2018).

At an individual level MH also has consequences. MH is directly associated with general health, social skills, education, and economic status. People reporting poor MH also report poor general health (Jensen et al., 2022), and studies show that people reporting poor MH experience less social inclusion, including social integration, affiliation to community and society, and the feeling of being a part of a community (Eplov & Lauridsen, 2008). Further, people with a low level of education and low socioeconomic status report worse MH than people with a higher level of education and socioeconomic status (SES) (Jensen et al., 2022). Thus, SES is an important determinant for MH (Jensen et al., 2022). Additionally, MH is associated with the individual's capability to contribute to society, which is associated with quality of life. People reporting poor MH are therefore at risk of decreased quality of life. The complex nature of MH emphasises that poor MH is a wicked problem with no simple solution (Rittel & Webber, 1973).

Young Danish women aged 16-34 years report poor MH with an increasing incidence over the last decade. This is one of the conclusions from the national survey The National Health Profile 2021 (Jensen et al., 2022). Since 2010 poor MH has increased from 15.8% among Danish women aged 16-24 years to 34.4% and from 14.3% among Danish women aged 25–34 years to 25.2% (Christensen et al., 2010). Danish women aged 16-34 years have the highest proportion of poor MH in Denmark (Jensen et al., 2022).

MH has no generally accepted definition, and the term is applied in different ways in different contexts. The World Health Organisation (WHO) defines MH as:

> *Mental health is a state of well-being in which an individual realises his or her own abilities, can cope with the normal stresses of life, can work productively and is able to make a contribution to his or her community.* (https://www.who.int/news-room/fact-sheets/detail/mental-health-strengthening-our-response)

This definition of MH is accepted by the Danish Health Authority (Danish Health Authorities, 2018).

Studies have shown that physical activity (PA) is positively associated with MH (Asztalos et al., 2010; Bertheussen, et al., 2011; Brown, et al., 2000; Galper, et al., 2006; Iwon et al., 2021; Kull, 2002; Marques, et al., 2016; Richards, et al., 2015) and is therefore an essential part of daily life (Eplov & Lauridsen, 2008). PA is a broad term defined as *any bodily movement produced by skeletal muscles that require energy expenditure* (https://www.who.int/news-room/fact-sheets/detail/physical-activity). This broad definition contains multiple elements, including among others exercise and sports. Exercise and sports are more changeable terms, and they are affected by the time and culture in which they are used. In a Danish context, exercise is a common term used for types of PA practised mostly during leisure time with a focus on the physical movement of the body. Sports, on the other hand, is a more traditional term describing the Danish culture of sports often containing elements of competition focusing more on bodily coordination than the physical movement of the body (https://doi.org/10.7146/ffi.v26i2.31606).

PA are often understood based on different levels of duration and intensity. Danish People aged 18–64 years are recommended to be physically active at least 30 minutes a day with a moderate to high intensity. Furthermore, people are recommended to be physically active with high intensity twice a week for at least 20 minutes resulting in an adequately physically active everyday life when being physically active 210 minutes or more a week (Danish Health Authorities, 2019).

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AIMS

This study aims to investigate whether PA is associated with higher odds for MH in Danish women aged 16–34 years and to investigate the significance of the weekly duration (from here referred to as duration) of PA.

BACKGROUND

Studies investigating the association between PA and MH in women are limited, but some studies including both genders report gender-specific results allowing the reader to study the association among women. The evidence on the association is difficult to compare since PA is a broad term investigated on different elements, and MH has no generally accepted definition. However, studies investigating the association still indicate trends in the association between PA and MH among women.

Iwon et al. (2021) found that PA was strongly associated with MH. Physically active women reported higher levels of subjective well-being, including happiness and self-esteem than women who recently started being physically active or were inactive. Furthermore, the study found that women who started exercising at baseline after 4 weeks reported greater subjective well-being (Iwon et al., 2021). Further, Bertheussen et al. (2011) investigated the association between the frequency, duration, and intensity of PA and MH based on the international recommendations of at least 150 minutes per week with moderate intensity or 75 minutes per week with vigorous intensity. The study found that women aged 19–64 years reported better MH when exercising at or above the recommended level compared to women exercising below the recommended level of PA. The study found a dose-response association in all levels of PA (Bertheussen et al., 2011).

Other studies investigated the association in European countries, including Denmark (Marques et al., 2016; Richards, et al., 2015). Marques et al. (2016) investigated the association between PA and self-rated well-being in 27 European countries. The study found that women attaining the recommended levels of PA according to WHO (≥30 min of at least moderate PA on five or more occasions per week) reported significantly higher MH than women not attaining the recommended level of PA (Marques et al., 2016). Additionally, Richards et al. (2015) investigated the relationship between PA and MH measured through happiness in 15 European countries, including Denmark. The study found a significant association between vigorous PA and happiness in women (Richards et al., 2015). More studies also found a positive association between PA and MH (Brown, et al., 2000; Galper, et al., 2006; Kull, 2002).

METHODS

STUDY DESIGN AND DATA COLLECTION

This is an analytic cross-sectional study investigating the association between PA and MH and the significance of the duration of PA among Danish women aged 16–34 years.

Data in this study originated from the Danish national survey Sports participation among the Danes 2020 (Idrættens Analyseinstitut, 2021). The survey consists of about 100 questions about the Danes' exercise and sports habits (Kirkegaard, & Pallesen, 2021), and it investigates how, where, what, and why Danes exercise or participate in sports (Idrættens Analyseinstitut, 2021). The data was collected by Rambøll Management Consulting on behalf of The Danish Institute for Sports Studies (Idan) (Kirkegaard, & Pallesen, 2021).

The collection of data was carried out in a random sample of 20,365 Danes aged 16 years and above. The participants were invited to participate through an e-Boks message (the Danish public digital mailbox) in October 2020 with a description of the aim and the content of the survey and a link to the questionnaire. Two weeks after, in November 2022, the first reminder was sent out, and a second reminder was sent out six weeks after the invitation. The participants had eight weeks from the invitation to answer the questionnaire (Kirkegaard, & Pallesen, 2021). The questionnaire was answered by 6,917 Danes corresponding to a response rate at 34% (Kirkegaard, & Pallesen, 2021).

STUDY POPULATION

The study population was respondents of the survey Sports participation among the Danes 2020. Figure 1 shows the in- and exclusion criteria as well as the final study population. The exclusion criteria were male participants and participants above 34 years. The final study population in this study was 756 Danish women aged 16–34 years (Figure 1).

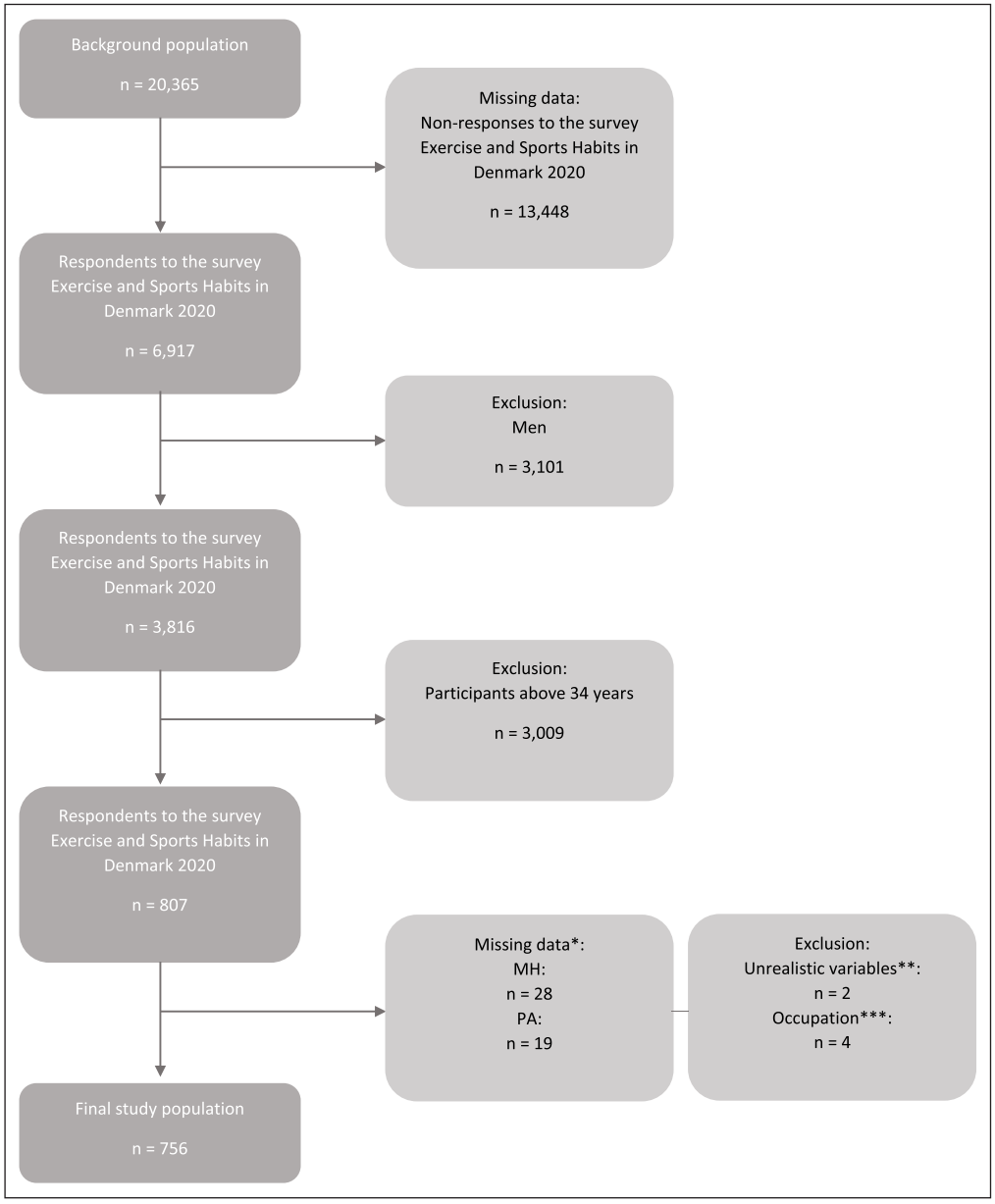

Figure 1 Study population (flowchart).

* Missing data summarise 45 since data is missing on both variables for the same participants.

** One participant answered being physically active 2020 hours/week, and one participant answered being at pension.

*** 4 participants answered stay-at-home as occupation. Since all 4 were categorised with high MH, it was not possible to estimate odds for low MH and they were therefore excluded from this study.

MEASURES

Exposure

PA was measured through the question: '*How much time do you normally spend on sports/exercise per week (minus travel time)?*' The participants estimated the time in hours and minutes per week spend on sports/exercise. The hours were converted into minutes and summarised with minutes resulting in the total number of minutes per week normally spend on sports/exercise (minus travel time). The variable was categorised into respectively adequately and inadequately physical activity in relation to the Danish recommendations for PA: Being physically active for 210 minutes per week or more (Danish Health Authorities, 2019). Adequately physically active were participants spending 210 minutes or more per week, while inadequately physically active were participants spending less than 210 minutes per week on sports/exercise. To investigate the significance of the duration of PA, PA was applied as a continuous variable with total minutes per week normally spend on sports/exercise (minus travel time).

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Outcome

MH was measured through the WHO-5 Well-Being Index (WHO-5) which is validated and has been translated into Danish (Topp et al., 2015). The participants were asked '*How often over the last two weeks have you...?*' followed by five statements with six possible answers to each statement giving a scale from 0 to 100 with 0 representing the worst well-being and 100 representing the best well-being. More detailed information about the WHO-5 has been described elsewhere (Topp et al., 2015).

WHO-5 was classified as respectively high and low MH. WHO-5 scores from 0 to 70 represented low MH, and WHO-5 scores at 70 or above represented high MH. Cut-off at 70 was selected since it represents the mean score of the Danish general population (Topp et al., 2015). When the significance of the duration of PA was investigated, the WHO-5 score was applied as a continuous variable.

STATISTICAL ANALYSES

All statistical analyses were performed in Stata/IC 16.1.

Descriptive analysis

A descriptive analysis was performed to investigate the Danish women's characteristics according to potential confounders and the outcome (MH), categorised into respectively inadequately and adequately physically active women. The relative distribution was calculated, and Pearson's χ^2-test was performed with a significance level of 0.05 to test whether the distribution was the same among respectively adequately and inadequately physically active women.

Main analyses

To investigate whether PA is associated with MH multiple logistic regressions were performed with odds ratios (OR) as a measure of association with a 95% confident interval (CI). A non-adjusted OR and an adjusted OR were estimated with adjustment for age, education, occupation, relationship status, living situation, and life events. Additionally, the Wald test was performed with a 0.05 significance level. In the analyses, adequately physically active women were applied as a reference.

To investigate the significance of the duration of PA multiple linear regression was performed with adjustment for the above-mentioned potential confounders. The linear regression was followed by a t-test with a significance level at 0.05 to test for trend.

ETHICAL CONSIDERATIONS

Data in this study originated from the Danish national survey Sports participation among the Danes 2020. The survey was carried out by Idan and was reported to The Danish Data Protection Agency. Collecting and analysing data as well as passing on sensitive personal data was based on article 6, part 1, litra e in the *General Data Protection Regulation* (GDPR): Survey of societal interest. Additionally, Idan used the participants' identification numbers to enable comparison across years and to communicate via e-Boks. This was based on §11 in the Danish Data Protection Act. In the invitation to the survey Idan linked to their politic on personal data. To comply with GDPR (Harlev, 2021) data in the study was fully anonymised.

RESULTS

THE CHARACTERISTICS OF THE STUDY POPULATION

The characteristics of the study population are presented in Table 1.

Overall, the characteristics of the exposure groups were statistically significant different in all variables of interest except compared to life events (Table 1). The most distinctive differences were as follows: Adequately physically active women had a larger proportion with high school as the highest completed education (34.95%) than inadequately physically active women (22.97%). The inadequately physically active women had a larger proportion of higher educations as the

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	INADEQUATELY PHYSICALLY ACTIVE N (%) = 344 (45.5)	ADEQUATELY PHYSICALLY ACTIVE N (%) = 412 (54.5)	TOTAL SAMPLE N (%) = 756 (100)	*P**
	n (%)	n (%)	n (%)	
Age				
16–24	118 (34.30)	213 (51.70)	331 (43.78)	<0.001
25–34	226 (65.70)	199 (48.30)	425 (56.22)	
Education				
Elementary school	35 (10.17)	56 (13.59)	91 (12.04)	<0.001
High school	79 (22.97)	144 (34.95)	223 (29.50)	
Vocational school	45 (13.08)	27 (6.55)	72 (9.52)	
Higher education 3–4 years	88 (25.58)	82 (19.90)	170 (22.49)	
Higher education above 4 years	69 (20.06)	77 (18.69)	146 (19.31)	
Other education	28 (8.14)	26 (6.31)	54 (7.14)	
Occupation				
Self-employed	8 (2.33)	17 (4.13)	25 (3.31)	<0.001
Public servant	76 (22.09)	74 (17.96)	150 (19.84)	
Skilled worker	58 (16.86)	29 (7.04)	87 (11.51)	
Unskilled worker	25 (7.27)	29 (7.04)	54 (7.14)	
Leave of absence	11 (3.20)	11 (2.67)	22 (2.91)	
Unoccupied	19 (5.52)	23 (5.58)	42 (5.56)	
Enrolled in education	113 (32.85)	190 (46.12)	303 (40.08)	
Other	34 (9.88)	39 (9.47)	73 (9.66)	
Relationship status				
In a relationship	256 (74.42)	235 (57.04)	491 (64.95)	<0.001
Single	87 (25.29)	169 (41.02)	256 (33.86)	
Other	1 (0.29)	8 (1.94)	9 (1.19)	
Living situation				
Living alone (with/ without children)	43 (12.50)	79 (19.17)	122 (16.14)	<0.001
Living with spouse/ cohabitee/partner (with/without children)	213 (61.92)	164 (39.81)	377 (49.87)	
Living with one or more roommates	28 (8.14)	66 (16.02)	94 (12.43)	
Living at my parent's house	56 (16.28)	94 (22.82)	150 (19.84)	
Other	4 (1.16)	9 (2.18)	13 (1.72)	
Life events				
No	76 (22.09)	100 (24.27)	176 (23.28)	0.480
Yes	268 (77.91)	312 (75.73)	580 (76.72)	
Mental health				
Low MH	266 (77.33)	287 (69.66)	553 (73.15)	0.018
High MH	78 (22.67)	125 (30.34)	203 (26.85)	

Table 1 The characteristics of the study population.

* P-value from a Pearson's χ^2-test with a significance level of 0.05.

highest completed education (45.64%) than adequately physically active women (38.59%). In most of the occupation categories, the proportions in the two exposure groups were similar, but some occupation categories were different. Inadequately physically active women had a larger proportion of women working as public servants (22.09%) and skilled workers (16.86%) than adequately physically active women (17.96% and 7.04%). Adequately physically active women had a larger proportion of women enrolled in education (46.12%) than inadequately physically active women (32.85%). Additionally, a larger proportion of inadequately physically active women were in a relationship (74.42%) than adequately physically active women (57.04%). Inadequately physically active women had a larger proportion of women living with a spouse/cohabitee/partner (61.92%) than adequately physically active women (39.81%). On the other hand, adequately physically active women had larger proportions of women living alone (19.17%), living with one or more roommates (16.02%), and living at their parent's house (22.82%) than inadequately physically active women (Table 1).

MH was statistically significant different in the exposure groups (p = 0.018). 77.33% of inadequately physically active women reported low MH whereas 69.66% of adequately physically active women reported low MH. 22.67% of inadequately physically active women reported high MH, and 30.34% of adequately physically active women reported high MH (Table 1).

THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY AND MENTAL HEALTH

The association between PA and MH was investigated through an unadjusted and an adjusted analysis with a 95% CI, and a Wald test with a p-value with a significance level of 0.05 (Table 2).

	N (%)	UNADJUSTED			ADJUSTED*		
		OR	CI (95%)	*P***	OR	CI (95%)	*P***
Physical activity							
Inadequately physically active	344 (45.5)	0.67	(0.49; 0.93)	0.018	0.62	(0.43; 0.87)	0.007
Adequately physically active	412 (54.5)	1	reference	–	1	reference	–

Table 2 The association between physical activity and mental health.

* Analysis adjusted for age, education, occupation, relationship status, living situation, and life events.

** P-value from Wald test with a significance level of 0.05.

The unadjusted OR was 0.67 (CI 0.49;0.93) meaning that inadequately physically active women had 33% lower odds for high MH than adequately physically active women. The CI showed that odds for high MH with 95% probability were between 51% and 7% lower for women being inadequately physically active compared to women being adequately physically active. The p-value of 0.018 was below the significance level of 0.05 meaning that the unadjusted analysis showed a statistically significant difference in MH between Danish women aged 16–34 years being respectively inadequately and adequately physically active.

The adjusted analysis was adjusted for age, education, occupation, relationship status, living situation, and life events. All potential confounders were included as categorical variables unless age which was included as a continuous variable. The adjusted OR was 0.62 (CI 0.43; 0.87) meaning that inadequately physically active women had 38% lower odds for high MH than women being adequately physically active. The CI showed that odds for high MH with 95% probability were between 57% and 13% lower for women being inadequately physically active compared to women being adequately physically active. The p-value of 0.007 was below the significance level of 0.05 meaning that the adjusted analysis showed a statistically significant difference in MH between Danish women aged 16–34 years being respectively inadequately and adequately physically active according to the Danish recommendations of PA.

THE SIGNIFICANCE OF THE DURATION OF PHYSICAL ACTIVITY

The significance of the duration of PA was investigated through an adjusted linear regression followed by a t-test with a 0.05 significance level. The test for trend showed a p-value under 0.001 which was below the significance level of 0.05 showing a statistically significant significance of the duration of PA for MH among Danish women aged 16–34 years. The analysis showed a positive dose-response association between PA and MH with a coefficient of 0.013

(CI 0.007;0.019). This means that for every 100 minutes added to PA per week the women's MH would increase by 1.3 on the WHO-5 scale. The CI at 0.007; 0.019 showed that for every 100 minutes added to PA per week MH would with a 95% probability increase between 0.7 points and 1.9 points at the WHO-5. The dose-response association is shown in Figure 2.

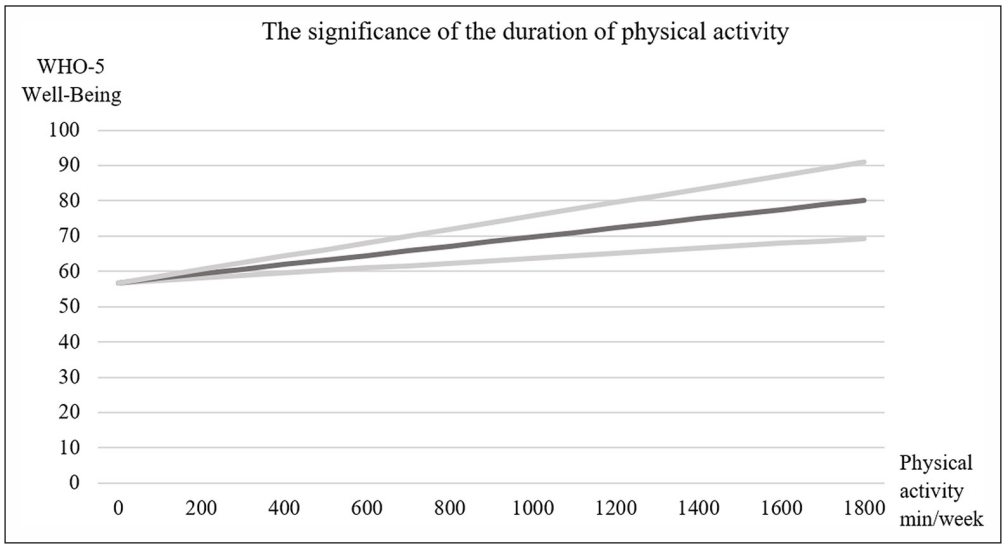

Figure 2 The significance of the duration of PA with coefficient and 95% CI.

DISCUSSION

THE RESULTS OF THE STUDY

The descriptive analysis showed a statistically significant difference between the exposure groups in all variables of interest except life events (Table 1).

Most results of the descriptive analysis were in line with other studies of determinants of PA (Ryom et al., 2021), including occupation, relationship status, and living situation. However, this study found that adequately physically active women had a larger proportion with high school as the highest completed education (34.95%) than inadequately physically active women (22.97%). Existing literature emphasised that level of education is an important determinant of PA (Ryom et al., 2021). The explanation for the finding in this study could be, that the participants were asked about their highest *completed* education. This means that participants enrolled in higher education 3-4 years had high school as the highest completed education at the time of data collection. This was also in line with the results showing, that a larger proportion of adequately physically active women were enrolled in education. Furthermore, the inadequately physically active women had a larger proportion of higher educations as the highest completed education (45.64%) than adequately physically active women (38.59%). The explanation for this finding could be, that the inadequately physically active women also had a larger proportion of women working as public servants (22.09%) and skilled workers (16.86%), which often is more sedentary work. Further, studies show that women become more physical inactive when entering the labour market (Ryom et al., 2021).

Additionally, life events were not statistically significant different in the exposure groups but were still included in the adjusted analysis. Life events were included since the descriptive analysis cannot be used as a determination of confounders (VanderWeele, 2019). According to the existing literature, life events are associated with PA and MH and are not an intermediate variable between PA and MH (WHO, 2019; Ryom et al., 2021).

MH was statistically significant different in the exposure groups. The cut-off in this study is recommended for clinical trials (Topp et al., 2015), and since clinical trials are solidly assessed, the cut-off was high in this study. Even though other studies use a lower cut-off (Topp et al., 2015), the solid cut-off was assessed most applicable in this study.

In the adjusted analyses age, education, occupation, relationship status, living situation, and life events were included. The adjusted analysis found an OR at 0.62 (CI 0.43; 0.87), and a p-value at 0.007 confirmed the positive association between PA and MH. Additionally, the

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analysis of the significance of the duration of PA showed a statistically significant significance ($p < 0.001$) with a coefficient of 0.013 (CI 0.007; 0.019) at which the hypothesis about the positive dose-response association was confirmed.

Comparison with the existing literature

The existing literature on the association between PA and MH use different definitions and measures. Therefore, a comparison with the existing literature was done cautiously. At a general level, the existing literature unanimously found positive associations between PA and MH among women (Asztalos et al., 2010; Bertheussen, et al., 2011; Brown, et al., 2000; Galper, et al., 2006; Iwon et al., 2021; Kull, 2002; Marques, et al., 2016; Richards, et al., 2015). The results of this study support these findings. A follow-up study (Iwon et al., 2021) and a cross-sectional study (Bertheussen, et al., 2011) defined PA in the same way as this study (WHO, 2019) which increase the comparability to this study. Further, Bertheussen et al. (2011) applied international recommendations on PA as the cut-off. These recommendations are similar to the Danish recommendations which is applied as the cut-off in this study (Danish Health Authorities, 2019). Therefore, with the results from this study, the evidence of the positive association between PA and MH among women is increased, when PA is defined as *any bodily movement produced by skeletal muscles that require energy expenditure* (WHO, 2019) and the cut-off follow recommendations on PA. Iwon et al. (2021) and Bertheussen et al. (2011) investigated women aged 18–65 years which is important to notice since age is associated with PA and MH (Danish Health Authoritites, 2018; Ryom et al., 2021). Marques et al. (2016) also included women aged 18–65 years in their cross-sectional study across 27 European countries which reduces the comparability to this study. On the other hand, Marques et al. (2016) also applied the international recommendations on PA, and therefore the study supports the evidence when using recommendations as cut-off. Further, Marques et al. (2016) included Danish women. Richards et al. (2015) also included Danish women in their cross-sectional study across 15 European countries, but their definition and measures of both PA and MH was different from this study, and the comparability is therefore limited. The different definitions and measures also apply for Kull's cross-sectional study investigating leisure time PA and psychological well-being (Kull, 2002), but Kull's focus on leisure time PA can be compared to this study, since this study include time spend on exercise and sports (minus travel time). Moreover, Kull investigated women aged 18–45 years, which is comparable to the study population in this study. Even more comparable age groups were investigated in Brown et al.'s cross-sectional study including women aged 18–23 years (Brown et al., 2000). Further, Brown et al. (2000) applied international recommendations for PA as cut-off. Brown et al. (2000) found a statistically significant association between PA and MH among Australian women aged 18–23 years. Therefore, with the results of this study, the evidence of the positive association between PA and MH among women in this age group is increased.

Despite different definitions, measurements, and ages of women investigated, the positive associations between PA and MH are unanimously, and the findings of this study support the existing evidence on the positive association among women. Further, this study adds attention to the evidence among Danish women aged 16–34 years.

Besides investigating the association between PA and MH, several studies investigated the significance of different levels of PA, including frequency, duration, and intensity (Asztalos et al., 2010; Bertheussen, et al., 2011; Brown, et al., 2000; Galper, et al., 2006; Iwon et al., 2021; Kull, 2002; Marques, et al., 2016; Richards, et al., 2015). The results of these analyses vary across studies, and different measurements were applied to investigate the levels of PA.

Since this study investigated the significance of the duration of PA, the comparability on the significance of the level of PA is limited when considering frequency and intensity, but most studies indicate a significance of the levels. Bertheussen et al. (2011) also investigated the duration of PA with the duration measured as the average minutes of exercise. The study found a positive dose-response association. However, the association was not statistically significant (Bertheussen et al., 2011). Also, Iwon et al. (2021) found a positive dose-response between average duration of PA and subjective well-being. This study found a statistically significant significance of the duration with the duration measured as minutes per week spend on exercise and sports. Therefore, the findings in this study support the studies that found a positive dose-response association between levels of PA and MH, and especially the results from studies

investigating the duration of PA. However, a study indicates that women exercising 4–6 times a week reported a higher MH compared to women exercising 7 times a week (Bertheussen et al., 2011). Another study found that odds for high MH were higher among women walking compared to moderate active women and that moderate active women reported higher MH than vigorous active women (Asztalos et al., 2010). Therefore, further research investigating the duration of PA is necessary to obtain additional knowledge about the duration. Knowledge about whether there is a point from where the duration of PA does not increase MH or maybe even have harmful effects on the MH is important.

STRENGTHS AND LIMITATIONS OF THE STUDY

There were several strengths of this study. First and foremost, the study included 756 Danish women aged 16–34 years, and the amount of data resulted in high reliability in the estimations.

Another strength in this study was the measure of MH. MH was measured through the WHO-5 that has high validity (Topp et al., 2015) and reliability (Halliday et al., 2017). The WHO-5 measures positive aspects of MH and was an applicable measure for MH with high construct validity. A further strength of this study was the data collection. Data were collected in a random sample of 20,365 Danes. The random sample was extracted by Rambøll Management Consulting for this study and was compared to the general Danish population based on data from Statistics Denmark to compare the representativity. Lower educations were underrepresented and higher education 3–4 years was overrepresented in this study but otherwise the study population was representative of Danish women aged 16–34 years. The random sample prevented selection problems.

This study included adjustment for potential confounders, and it was possible to adjust for all available variables of interest with all available categories, and age fulfilled the assumptions for a continuous variable. This prevented residual confounding. However, rest confounding could not be precluded since it was not possible to adjust for ethnicity (Brown et al., 2000). This was a limitation. Furthermore, the cut-off of PA has not been validated, and it can be discussed whether this cut-off is the most applicable when investigating the association between PA and MH. Another study (Kull, 2002) could indicate that a lower cut-off could be preferable. If so, the association found in this study would be underestimated. Additionally, the construct validity was challenged since exercise and sports were not conceptualised in the questionnaire, but there was a limited risk of differential misclassification. Further, since the study found an association between PA and MH, the association could not be caused by non-differential misclassification. There were limitations and potential problems with PA, and the risk of an underestimation of the association between PA and MH could not be precluded, but the risk of information bias was assessed to be low.

Another limitation in this study was the cut-off of MH. The cut-off was chosen since a cut-off at the general population's mean score of the WHO-5 is ideal when using WHO-5 as an outcome measure in clinical trials (Topp et al., 2015), and the mean score in the Danish population is 70 (Bech et al., 2003). This study was not a clinical trial, but since this study applied the WHO-5 as an outcome measure in a part of the general Danish population, it was assessed that the cut-off was suitable for this study as well. However, the cut-off at 70 has not been tested for sensitivity and specificity which challenge the validity of the outcome measure in the logistic regressions. Future studies investigating the sensitivity and specificity for cut-off at 70 in the WHO-5 are preferable.

This article is explicit in the focus on the duration of physical activity, as this is what the Danish health authorities highlight as important. However, the authors are aware that intensity, frequency and types of physical activity are also important (Krustrup et al., 2018). But as the Danish recommendations focus on duration, the authors think it is most relevant to examine duration. Thus, other elements such as intensity, frequency and type are not in our scope in this article.

CONCLUSION

This study investigated whether PA was associated with higher odds for MH among Danish women aged 16–34 years. The study found a statistically significant association between PA and MH.

Additionally, the study investigated the significance of the weekly duration of PA. The study found a statistically significance of the duration with a positive dose-response association between the duration of PA and MH among Danish women aged 16–34 years.

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COMPETING INTERESTS

This study was a collaboration between Aarhus University and The Danish Institute for Sports Studies (Idan). Idan delivered data to this study and was used as a sounding board for data collection and other methodical aspects.

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