

## RESEARCH

# 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

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A cross-sectional study design was used to examine associations between frequency of physical activity and participation in sports with mental wellbeing, and symptoms of depression and anxiety. Surveys were completed in post-primary schools by 5,661 adolescents from the Republic of Ireland. Validated instruments were used to assess frequency of physical activity, participation in sports, mental wellbeing (WEMWS), depressive symptoms (BDI) and anxiety (BAI). A minority of the sample (11.5% of males and 5.3% of females) were found to meet WHO's physical activity guidelines (60 minutes or more each day). Frequency of activity were found to decline with age. Frequency of activity was positively associated with wellbeing and negatively associated with symptoms of anxiety and depression. Males had higher levels of wellbeing and lower levels of anxiety and depressive symptoms across all sub-groups. Adolescents who engaged in sports were found to have higher levels of wellbeing and lower symptoms of anxiety and depression with team sport conferring an additional benefit. Future physical activity recommendations for children and adolescents should include mental as well as physical health benefits.

**Keywords:** Exercise; Team sport; Health; School

## Introduction

It is important to participate regularly in physical activity to improve the likelihood of living a healthy life. To assist people living a healthy life, there are specific physical activity guidelines (Hallal et al., 2006). Children and adolescents aged 5–17 years should accumulate 60 minutes of moderate-to-vigorous physical activity (MVPA) each day according to international recommendations (World Health Organisation, 2010). It has been reported however, that up to 80% of younger adolescents (13–15 years) do not meet the recommendations (Hallal et al., 2012), while only 13% of European adolescents (McMahon et al., 2017), and 10% of Irish adolescents meet the recommendations (Woods et al., 2019). Internationally, physical activity levels have decreased with age across adolescence, with females reporting significantly lower engagement in physical activity than their male counterparts in the majority of countries (Currie et al., 2009).

Conclusive evidence has demonstrated that the physical health of adolescents is enhanced through a higher frequency of physical activity (Janssen & Leblanc, 2010; Strong et al., 2005), there is also widespread belief that physical activity is inherently good for young people in respect of varied psychosocial outcomes, such as self-esteem and cognitive functioning (Biddle & Asare, 2011), with the most evidence about depression and anxiety (Abu-Omar et al., 2004; Dinas et al., 2011; Sieverdes et al., 2011). Suicide, depression, eating disorders and anxiety are some of the conditions that affect young people in disproportionate rates in comparison to many other population groups (Viner & Booy, 2005). McPhie & Rawana (2015) found greater levels of resiliency against symptoms of depression in adolescents who engaged in higher frequencies of physical activity in a longitudinal study. Regular physical activity also appears to be protective against anxiety

disorders (Carek et al., 2011; Strohle, 2009) while reduced levels of suicidal ideation has been associated with engagement in sporting activities.

A recent review of reviews on physical activity and mental wellbeing in adolescents (Biddle, Ciaccioni, Thomas & Vergeer, 2019) found that those who are physically active seem less likely to suffer from mental health problems and may have enhanced cognitive functioning with greater effects more likely in those with poorer mental health at baseline. A European wide study (McMahon et al., 2017) on the associations of physical activity with anxiety, depression and mental wellbeing found that lower levels of depression and anxiety in adolescents were associated with higher frequencies of physical activity as well as greater levels of wellbeing. They also found that participation in sport provided additional benefits to mental health regardless of frequency of activity with girls who play team sport, in particular, having significantly lower levels of depression and anxiety. These findings go some way to support the hypothesis that psychosocial interactions are significant contributors to the mental health benefits provided by physical activity (McMahon et al., 2017; Lubans et al., 2016).

The *My World Survey, A National Study of Youth Mental Health in Ireland* (Dooley, Fitzgerald & Giollabhui, 2012) found approximately one third of adolescents to be suffering from elevated levels of depression and anxiety. A follow up study, *Jigsaw My World Health Survey 2* reported that 40% of participants suffered from mild to very severe depression and 49% suffered from mild to very severe anxiety (Dooley, O'Connor, Fitzgerald & O'Reilly, 2019). This increase highlights the growing, and worrying, upward trend of mental health difficulties experienced by Irish adolescents.

While mental health difficulties have increased among Irish adolescents, physical activity levels have decreased. The *Children's Sport and Physical Activity Study* (CSPPA) (Woods, Moyna & Quinlan, 2010) found that 12% of adolescents met the physical activity requirements in 2010 while this had decreased to 10% in the 2019 follow-up study (Woods et al., 2019). The relationship between this increase in mental health difficulties and decrease in physical activity levels has been previously unexplored in an Irish context. The current study sought to explore the associations between physical activity and mental health and wellbeing indicators to further understand the bi-directional relationship between physical activity and mental health in adolescents. Our objectives were to describe the frequency of physical activity and engagement in sport among males and females aged 11 to 20 and to examine associations between frequency of physical activity and engagement in sport with wellbeing, and symptoms of depression and anxiety. We hypothesised that the majority of adolescents would not meet WHO physical activity recommendations, that females would have lower frequencies of physical activity than males and that more frequent exposures to physical activity would be associated with higher levels of wellbeing and lower symptoms of depression and anxiety.

## Method

A cross-sectional study design was employed in the post-primary school setting. Invitations to participate were circulated via the University's social media platforms where interested principals/teachers could register via an online form. Data collection took place during September and October 2019.

### Data Collection

Written consent from each school's Principal was sought prior to the distribution of questionnaires. Parental consent forms and plain language statements were given to all students prior to the questionnaire being issued. Participants were informed that their responses would be treated in strictest confidence and that all responses were entirely anonymous. They were encouraged to take time, reflect on their answers, and to be as honest as possible. All questionnaires were administered through an online form and could be completed via desktop computer, laptop, tablet or mobile phone. An option to contact the National Education Psychologists Service (NEPS) was offered to participants after completion of the questionnaire if they wished to discuss anything from the questionnaire with a suitably qualified professional. The means of administering the questionnaire was at the discretion of each participating school.

### Physical activity

Habitual physical activity was assessed via a modified version of the Take PART questionnaire by measuring the number of days during the past 14 that participants had accumulated 60 minutes of moderate-to-vigorous physical activity (MVPA) which was previously validated in an Irish adolescent population (Woods et al., 2009). The survey item assessing physical activity was as follows: "During a typical 2-week period, on how many days were you physically active for a total of at least 60 minutes? For each day, add up all the time you spent in physical activity like walking, riding a bicycle etc. Count up the days with at least 60 minutes of physical activity in a typical 2-week period." A graphic summarising moderate-to-vigorous physical activity,

with examples, was also included in the questionnaire to aid participants in gauging the intensity of their exercise. Responses ranged from 0 to 14 days.

### **Participation in sport**

A further survey item asked about regular (at least one time per week) engagement in one or more sports during the past 6 months, with possible responses “Yes” or “No” (McMahon et al., 2017). Participants could list the sports they engaged in, with the options to provide up to three sports. The study team counted all sports that were listed, and coded participants based on “0”, “1”, “2” or “3+” sports. Listed sports were later coded by the study team as either individual/fitness activity or team sport. The working definition of team sport was “those that typically involved three or more players on each side who compete concurrently” (Zhou, Heim & O’Brien, 2015). Participants who listed at least one sport that was classified as “team sport” were assigned to that category. Participants who listed individual sports or fitness activities were assigned to the, but no teams port were assigned to the “individual sport/fitness activity” category.

### **Mental health**

**Depressive symptoms:** Depressive symptoms were measured using the Beck Depression Inventory (BDI) (Beck, Steer & Carbin, 1988). The BDI assesses specific symptoms of depression experienced by participants over the previous two weeks. One question pertaining to loss of libido was excluded from the current questionnaire as it is deemed inappropriate for an adolescent population (Kendall, Hollon, Beck, Hammen & Ingram, 1987). Question responses are scored from 0 to 3, with 3 indicating higher severity of a symptom. Total scores on the BDI range from 0 to 60 with higher scores indicating higher severity of symptoms. Responses demonstrated excellent internal reliability with a Cronbach’s Alpha of 0.94 (Beck & Steer, 1984). The BDI has demonstrated very good reliability and validity in both clinical and community samples of adolescents (Teri, 1982; Steer, Kumar, Ranieri & Beck, 1998).

**Anxiety symptoms:** Anxiety symptoms were measured using the Beck Anxiety Inventory (BAI) (Steer & Beck, 1997), a 21-item self-report questionnaire. Question responses are scored from 0 to 3, with 3 indicating higher severity of a symptom. Totals cores on the BAI range from 0 to 63 with higher scores indicating higher severity of symptoms. Responses demonstrated excellent internal reliability with a Cronbach’s Alpha of 0.93 (Ulusoy, Sahin & Erkmen, 1998). The BAI has previously shown good reliability and validity in adolescent samples (Fydrich, Dowdall & Chambless, 1992; Steer, Kumar, Ranieri & Beck, 1995).

**Wellbeing:** Wellbeing was assessed using the Warwick Edinburgh Mental Wellbeing Scale (WEMWS) (Stewart-Brown & Janmohamed, 2008), which measures positive psychological wellbeing through a 14 item self-report questionnaire. Each question is scored from 1 to 5 with total possible scores ranging from 14 to 70. Higher scores (maximum 70) represents highest possible levels of wellbeing. Good internal reliability was demonstrated through a Cronbach’s Alpha of 0.83. The WEMWS has been psychometrically confirmed for use in adolescent samples (Clarke et al., 2011).

Age and year group were also recorded and have been included as covariates as previous work has shown associations between increases in age and lower frequencies of physical activity (Currie et al., 2009).

### **Statistical analyses**

Based on their reported frequency of physical activity, participants were categorised as Least Active (60 minutes or more of activity on 0–3 days in the past 14), Somewhat Active (60 minutes or more of activity on 4–7 days in past 14), or Most Active (60 minutes or more of activity on 8–14 days of the past 14). A further sub-group was also created who reported meeting the daily physical activity guidelines on all 14 days in a typical 2-week period (Sufficiently Active according to WHO guidelines). T-tests were used to compare mean frequency of physical activity between males and females.

Mean scores on the psychological variables (BDI, BAI, WEMWS) between the three physical activity sub-groups were compared using two-way ANOVA. Mean scores on the psychological variables (BDI, BAI, WEMWS) between females, males and other were also compared using two-way ANOVA. Tukey’s HSD with Bonferroni correction was used for post hoc between-groups comparisons.

Analyses were carried out separately for males and females due to the significant differences in prevalence of mental health problems and frequency of physical activity. Analyses were conducted in R (R Core Team, 2014) and figures were produced using the package ggplot2 (Wickham, 2009).

### **Research Ethics**

The study was approved by the DCU Ethics Committee (DCUREC/2019/107).

## Results

### *Participant characteristics*

144 schools initially registered interest in taking part. 65 schools were unable to participate fully due to either: commitments to other research; availability of time; or lack of Principal consent. The remaining 79 schools who registered interest represent 11% of the post-primary schools in Ireland. 5661 participants were recruited from these 79 schools throughout the Republic of Ireland with a minimum of one school from each of the 26 counties in Ireland giving a very good geographical spread. The number of student responses in each school ranged from 24 to 232.

In total, 5661 adolescents participated in the questionnaire. 3247 (57%) females, 2386 (42%) males and 28 (0.5%) who identified as neither female nor male (referred to as “other” for the purposes of reporting). Transition year had the most participants ( $n = 1411$ , 25%) followed by 3<sup>rd</sup> year ( $n = 1011$ , 18%), 5<sup>th</sup> year ( $n = 983$ , 17%), 2<sup>nd</sup> year ( $n = 894$ , 16%), 1<sup>st</sup> year ( $n = 872$ , 15%) and the least participants from 6<sup>th</sup> year ( $n = 490$ , 9%). Ages ranged from 11 to 20 years. The mean age of the sample was 14.8 ( $sd = 1.5$ ).

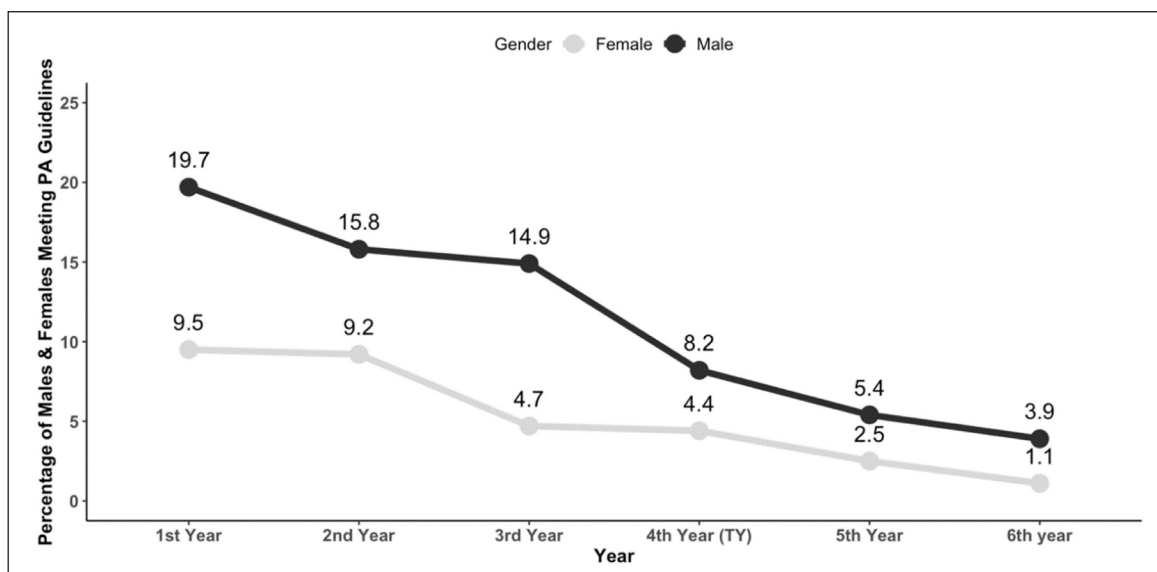
**Table 1:** Participants by year.

Year	Female	Male	Other	Total
1 <sup>st</sup> Year	495	375	2	872
2 <sup>nd</sup> Year	499	387	8	894
3 <sup>rd</sup> Year	601	402	8	1011
4 <sup>th</sup> Year	781	625	5	1411
5 <sup>th</sup> Year	591	390	2	983
6 <sup>th</sup> year	280	207	3	490
<b>Total</b>	<b>3247</b>	<b>2386</b>	<b>28</b>	<b>5661</b>

### *Frequency of physical activity and sports participation*

The current study found that, 275 (12%) males and 173 (5%) females engaged in at least 60 minutes of physical activity every day. 8% of the entire sample reported meeting physical activity guidelines. The percentage of adolescents meeting physical activity guidelines declined through post-primary school from 1<sup>st</sup> year (13.9%) through 2<sup>nd</sup> (12.2%), 3<sup>rd</sup> (8.8%), 4<sup>th</sup> (6%) and 5<sup>th</sup> year (3.7%) with the lowest percentage in 6<sup>th</sup> year (2.2%).

Significant differences were found in the proportion of young people in each of the three physical activity subgroups; with more females than males in the least active (22.8% of females, 12.1% of males) and somewhat active group (39.7% of females, 32.9% of males), and more males than females in the most active



**Figure 1:** Percentage of students meeting PA guidelines by year and gender.

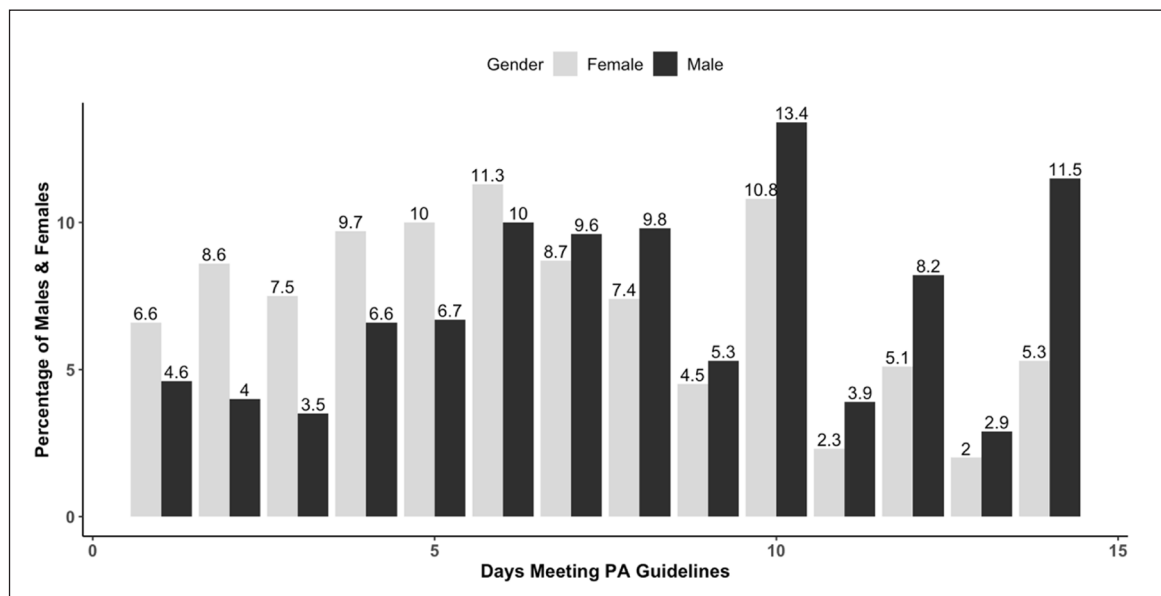
group (55% of males, 37.5% of females). The percentage of adolescents in the somewhat active group also declined through post-primary school from 1<sup>st</sup> year (54.1%) through 2<sup>nd</sup> (49.8%), 3<sup>rd</sup> (45%), 4<sup>th</sup> (42%) and 5<sup>th</sup> year (40.7%) with the lowest percentage in 6<sup>th</sup> year (35.6%).

**Table 2:** Frequency of physical activity among males and females by year.

	Least Active (0–3 days) (% within sex)		Somewhat Active (4–7 days) (% within sex)		Most Active (8–14 days) (% within sex)		Sufficiently Active (% within sex)	
	Male	Female	Male	Female	Male	Female	Male	Female
<b>1<sup>st</sup> Year</b>	8.8%	17.6%	26.9%	36.0%	64.3%	46.5%	19.7%	9.5%
<b>2<sup>nd</sup> Year</b>	11.1%	19.6%	31.0%	36.7%	57.9%	43.7%	15.8%	9.2%
<b>3<sup>rd</sup> Year</b>	11.9%	22.8%	29.9%	40.9%	58.2%	36.3%	14.9%	4.7%
<b>4<sup>th</sup> Year</b>	13.0%	24.1%	35.7%	41.4%	51.4%	34.6%	8.2%	4.4%
<b>5<sup>th</sup> Year</b>	14.4%	25.0%	33.6%	41.6%	52.1%	33.3%	5.4%	2.5%
<b>6<sup>th</sup> Year</b>	13.0%	29.0%	43.5%	40.9%	43.5%	30.1%	3.9%	1.1%
<b>Mean</b>	12.1%	22.8%	32.9%	39.7%	55.0%	37.5%	11.5%	5.3%

In the total sample, 80% of adolescents reported playing at least one sport while 66% reported engaging in team sport with large sex differences (58% of females, 76% of males). 20% of adolescents reported no participation in sport, either team or individual. The percentage of adolescents engaging in team sport declined from 1<sup>st</sup> year (76.7%) through 2<sup>nd</sup> (74.3%) and 3<sup>rd</sup> (66.7%) year before levelling off in 4<sup>th</sup> (58.4%), 5<sup>th</sup> (59.9%) and 6<sup>th</sup> year (59.8%).

The most frequently reported number of days where physical activity guidelines were met for boys was 10 (n = 320, 13%) followed by 14 (n = 275, 12%). The most frequently reported number of days in girls were 6 (n = 367, 11%) followed by 10 (n = 351, 11%).



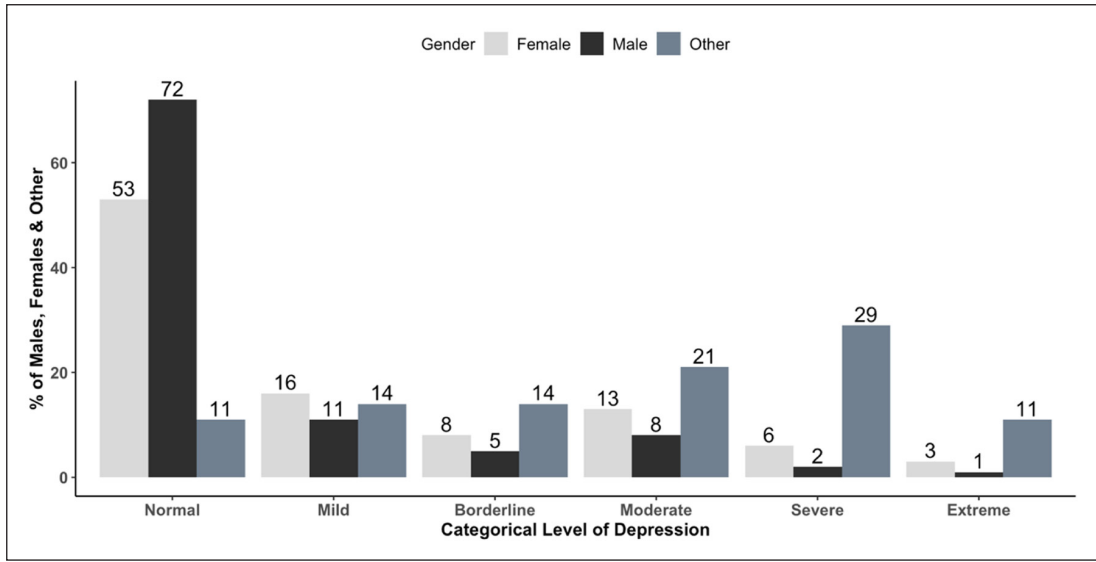
**Figure 2:** Days of physical activity 60+ min during past 2 weeks.

### **Mental health outcomes**

#### **Depressive symptoms: BDI**

Of the total sample, 39% of participants reported suffering mild to extreme forms of depression with 7% reporting either severe or extreme depression. 28% of males were in the mild to extreme ranges with 3% reporting as either severe or extreme. 47% of females were in the mild to extreme ranges with 9% reporting as either severe or extreme. 89% of other were in the mild to extreme ranges with 40% reporting as either

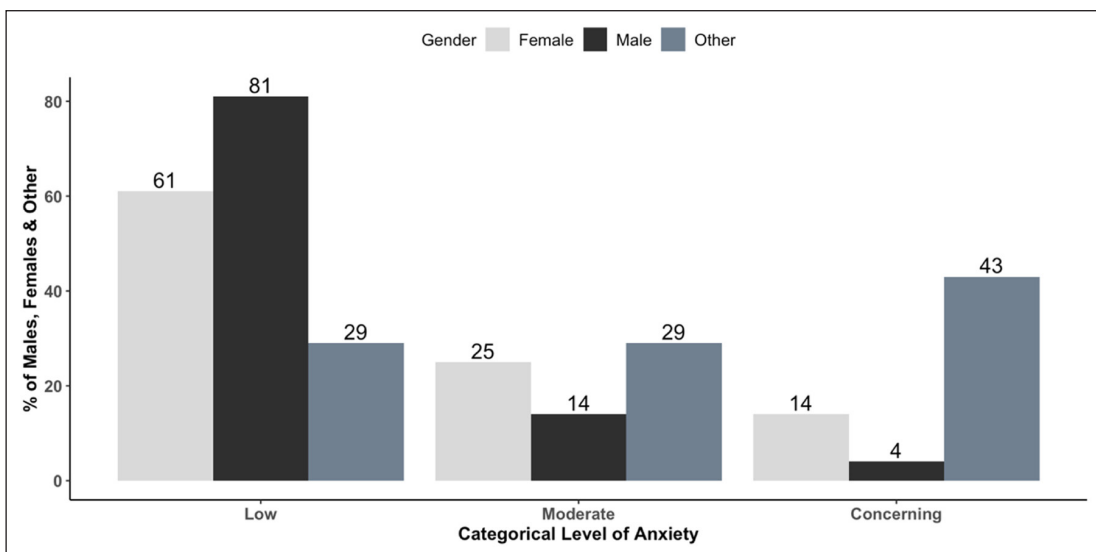
severe or extreme. 26% of 1<sup>st</sup> year students were in the mild to extreme range with 5% reporting as either severe or extreme. 37% of 2<sup>nd</sup> year students were in the mild to extreme ranges with 7% reporting as either severe or extreme. 44% of 3<sup>rd</sup> year students were in the mild to extreme ranges with 10% reporting as either severe or extreme. 39% of 4<sup>th</sup> year students were in the mild to extreme ranges with 7% reporting as either severe or extreme. 44% of 5<sup>th</sup> year students were in the mild to extreme ranges with 8% reporting as either severe or extreme. 46% of 6<sup>th</sup> year students were in the mild to extreme ranges with 7% reporting as either severe or extreme. Significant differences ( $p < 0.001$ ) were found between 1<sup>st</sup> years and all other year groups in mean depression scores. Significant differences ( $p = 0.002$ ) were also found between 2<sup>nd</sup> years and 3<sup>rd</sup> years, and 3<sup>rd</sup> years and 4<sup>th</sup> years. Significant differences ( $p < 0.001$ ) in mean depression scores were also found between all categories of gender: male, female, and other.



**Figure 3:** Participants by category of depression and gender.

**Anxiety symptoms: BAI**

31% of participants reported suffering moderate to concerning levels of anxiety. 19% of males were in the moderate to concerning categories. 39% of females were in the moderate to concerning categories while 71% of other were in the moderate to concerning categories. 22% of 1<sup>st</sup> year; 32% of 2<sup>nd</sup> year; 36% of third year; 31% of 4<sup>th</sup> year; 31% of 5<sup>th</sup> year; and 33% of 6<sup>th</sup> year students reported moderate to concerning levels of anxiety. Significant differences ( $p < 0.001$ ) in mean anxiety scores were found between 1<sup>st</sup> years and all other year groups. No other significant differences were found between year groups. Significant differences ( $P < 0.001$ ) in mean anxiety scores were also found between all categories of gender: male, female, and other.



**Figure 4:** Participants by category of anxiety and gender.

### Wellbeing: WEMWS

The mean wellbeing score of participants was  $46.9 \pm 9.3$  out of 70. Significant differences ( $p = 0.0002$ ) in mean wellbeing score were found between 1<sup>st</sup> years and all other year groups and between 2<sup>nd</sup> and 3<sup>rd</sup> years ( $p = 0.0005$ ), 2<sup>nd</sup> and 5<sup>th</sup> years ( $p = 0.0001$ ), 2<sup>nd</sup> and 6<sup>th</sup> years ( $p = 0.0001$ ), 3<sup>rd</sup> and 4<sup>th</sup> years ( $p = 0.0005$ ), 4<sup>th</sup> and 5<sup>th</sup> years ( $p = 0.001$ ), and 4<sup>th</sup> and 6<sup>th</sup> years ( $p = 0.0002$ ). Significant differences ( $p < 0.001$ ) in mean wellbeing score were also found between all categories of gender: male ( $49.4 \pm 8.6$ ), female ( $45.3 \pm 9.3$ ), and other ( $36.6 \pm 8.7$ ).

A significant, strong positive relationship ( $p < 0.001$ ,  $r = 0.69$ ) was found between depression and anxiety. A significant, strong negative relationship ( $p < 0.001$ ,  $r = -0.67$ ) was found between depression and wellbeing. A significant, moderate negative relationship ( $p < 0.001$ ,  $r = -0.51$ ) was found between anxiety and wellbeing.

**Table 3:** Mental health outcomes by year and gender.

Year	Depression Mean (SD)			Anxiety Mean (SD)			Wellbeing Mean (SD)		
	Male	Female	Other	Male	Female	Other	Male	Female	Other
1 <sup>st</sup>	6.5(8.6)	7.9(9.2)	19.5(00.7)	11.3(11.3)	14.7(12.4)	26.5(17.7)	51.1(8.1)	48.2(8.6)	36.5(3.5)
2 <sup>nd</sup>	8.7(10.5)	12.6(11.7)	25.1(16.3)	13.9(11.3)	19.5(13.8)	28.5(19.6)	49.4(9.3)	46.3(9.7)	35.4(5.2)
3 <sup>rd</sup>	9.1(10.2)	14.8(12.2)	23.0(13.8)	13.7(10.9)	21.2(13.8)	30.1(17.9)	48.5(8.8)	44.1(9.3)	40.6(5.9)
4 <sup>th</sup>	7.6(8.9)	13.5(11.2)	23.6(9.6)	12.5(10.6)	20.1(12.6)	28.0(9.9)	49.8(8.2)	45.5(9.1)	44.2(9.2)
5 <sup>th</sup>	8.4(9.7)	14.2(11.5)	38.0(4.2)	12.3(10.5)	20.2(13.1)	36.0(8.5)	49.0(9.1)	43.9(9.2)	24.5(6.4)
6 <sup>th</sup>	9.3(9.2)	14.1(11.4)	41.0(18.1)	12.6(10.5)	21.1(14.0)	47.0(14.7)	47.2(7.9)	43.3(9.3)	24.3(5.5)
Mean	8.4(9.6)	13.6(11.4)	26.7(14.2)	13.3(10.8)	19.1(13.4)	31.4(16.2)	49.4(8.6)	45.3(9.3)	36.6(8.7)

### ***Associations between frequency of physical activity, sport participation and mental health measures***

Significant differences were found between physical activity sub-groups on all of the mental health outcomes examined ( $p < 0.005$  for both males and females on BDI, BAI, WEMWS after Bonferroni correction). Lower symptoms of depression and anxiety, and higher levels of wellbeing were associated higher frequencies of physical activity.

Post hoc sub-group comparisons showed significant differences between the Least Active and Somewhat Active subgroups in terms of scores on all examined measures for both boys and girls, with the Somewhat Active group having lower depression and anxiety levels and higher wellbeing than the Least Active group. Comparisons between the Somewhat Active and Most Active subgroups showed significant differences among boys and girls for depression and anxiety (Most Active group having lower scores) and for wellbeing (Most Active group having higher scores).

Participation in sport was associated with significantly higher levels of wellbeing and lower levels of anxiety and depression ( $p < 0.001$  for both males and females on BDI, BAI, WEMWS after Bonferroni correction) with more sports leading to significantly greater levels of wellbeing and lower levels of anxiety and depression.

Posthoc analyses showed significant differences in wellbeing between males and females who played no sports and 1, 2 or 3+ sports, those who played 1 and 2, and 1 and 3+, but not between males or females who played 2 and 3+. Significant differences in anxiety were found between males who played no sport and those who played 1, 2 or 3+ sports but no significant difference between those who play 1 and 2, 1 and 3+, and 2 and 3+. Significant differences were shown in anxiety between females who played no sport and those who played 1, 2 or 3+ sports and in females who played 1 and 2 sports, and 1 and 3+ sports but no significant difference between those who play 2 and 3+. Significant differences in depression were found between males and females who played no sports and those who played 1, 2 or 3+. Significant differences were also found between males who played 1 and 3+ but not between males who played 1 and 2 or 2 and 3+. Significant differences were found between females who played 1 and 2, and 1 and 3+ but not between females who played 2 and 3+.

Team sport was associated with significantly higher levels of wellbeing and lower levels of anxiety and depression ( $p < 0.001$  for both males and females on BDI, BAI, WEMWS after Bonferroni correction).

**Table 4:** Number of sports played and associations with wellbeing, depression and anxiety by gender.

Physical Activity Subgroup	Percentage of		Wellbeing Mean (SD)		Depression Mean (SD)		Anxiety Mean (SD)	
	Male	Female	Male	Female	Male	Female	Male	Female
<b>Least Active</b> (0–3 days)	12.1%	22.8%	45.9(9.3)	42.0(9.9)	10.9(10.7)	16.3(12.9)	15.5(11.3)	22.5(14.0)
<b>Somewhat Active</b> (4–7 days)	32.9%	39.7%	48.9(8.2)	45.1(8.7)	8.6(9.4)	12.9(11.0)	13.2(11.4)	20.0(13.2)
<b>Most Active</b> (8–14 days)	55.0%	37.5%	50.4(8.5)	47.6(9.0)	7.3(9.2)	10.9(10.6)	11.8(10.3)	17.2(12.7)
<b>Number of Sports Played</b>	<b>Male</b>	<b>Female</b>	<b>Male</b>	<b>Female</b>	<b>Male</b>	<b>Female</b>	<b>Male</b>	<b>Female</b>
<b>0</b>	14%	24%	45.6(9.8)	41.9(9.7)	11.6(11.2)	17.0(12.7)	15.9(12.5)	23.1(14.1)
<b>1</b>	24%	32%	48.9(8.8)	44.8(9.1)	8.6(10.2)	13.2(11.2)	12.7(10.7)	20.2(13.3)
<b>2</b>	31%	27%	50.2(7.7)	47.0(8.6)	7.7(8.6)	10.9(10.3)	12.6(10.7)	17.4(12.6)
<b>3+</b>	31%	18%	50.5(8.4)	48.3(8.6)	6.8(8.7)	9.9(10.1)	11.5(10.2)	16.5(12.2)
<b>Team Sport</b>	<b>Male</b>	<b>Female</b>	<b>Male</b>	<b>Female</b>	<b>Male</b>	<b>Female</b>	<b>Male</b>	<b>Female</b>
<b>Yes</b>	76%	58%	50.1(8.2)	46.9(8.8)	7.3(8.8)	11.0(10.3)	11.8(10.1)	17.4(12.5)
<b>No</b>	24%	42%	47.1(9.6)	43.1(9.6)	10.7(11.1)	15.7(12.5)	15.7(12.5)	22.4(13.9)

## Discussion

A small minority (8%) of participants met physical activity recommendations (at least 60 minutes of MVPA each day) (WHO, 2010). Females were less likely to be active than males with only 5% of females meeting the WHO's physical activity guidelines in contrast to 12% of males, and decreased with age. This finding is similar to other national (Woods et al., 2019) and European wide studies of activity levels in adolescents (Currie et al., 2010; McMahon et al., 2017). The percentage of adolescents meeting physical activity guidelines (8%) is well below previous European studies (14%) (McMahon et al., 2017). These findings are also slightly below previous nationwide studies where it was found that only 12% and 10% of adolescents met physical activity guidelines respectively (Woods, Moyna & Quinlan, 2010; Woods et al., 2019). Significantly more boys (86%) engaged in sport than girls (77%) although both were much higher than previously recorded European levels (77% and 61% respectively). We found a larger disparity between males and females in terms of participation in team sport as 76% of males reported participating in at least one team sport as opposed to 58% of females. Previous work suggests that opportunities to participate in sport, and team sport in particular, may be biased in favour of boys (Currie et al., 2012). With so few adolescents meeting physical activity recommendations, despite the large proportion engaging in team sport, it would appear that there is a growing need for individual sports or fitness-based activities, particularly for adolescent females. We also found that physical activity levels reduced as adolescents progressed through school with the largest reduction from 2<sup>nd</sup> to 3<sup>rd</sup> year (14–15 years old) in females and from 3<sup>rd</sup> year to 4<sup>th</sup> year in males (15–16 years old) which is consistent with previous investigations of reductions in physical activity levels (Kimm et al., 2000; O'Donovan et al., 2010). This suggests physical activity interventions should target these at-risk groups in the future (Belton, O'Brien, Meegan, Woods & Issartel, 2014).

Our findings suggest two fifths of Irish adolescents are experiencing elevated levels of depression with one third experiencing elevated levels of anxiety. While concerning, this is in line with recent investigations of mental health issues in Ireland (Dooley et al., 2019), which appears to be moving in an upward trend over the past ten years (Lynch, Mills, Daly & Fitzpatrick, 2006; Martin, Carr, Burke, Carroll & Byrne, 2006; Sullivan, Keeley, Corcoran & Perry, 2004; Dooley, Fitzgerald & Giollabhui, 2012). Lowest levels of depression and anxiety were found in 1<sup>st</sup> years and moved in an upward trend with highest levels in 3<sup>rd</sup>, 5<sup>th</sup> and 6<sup>th</sup> year. This suggests the pressures associated with state exams in 3<sup>rd</sup> and 6<sup>th</sup> year may be contributory factors to elevated levels of depression and anxiety. A sharper rise in depression and anxiety was also found from 1<sup>st</sup> to 3<sup>rd</sup> year in females when compared to males. This is when the greatest reduction in levels of physical activity were also found in females which suggests a link between the two although it is difficult to identify cause and effect. The higher prevalence of depression and anxiety in females is consistent with Irish (Dooley et al., 2019) and international (Kieling et al., 2011) research, although the alarmingly elevated levels of depression



and anxiety in those who identify as neither male nor female is particularly concerning and not previously reported in an Irish context. Higher levels of wellbeing were associated with higher frequencies of physical activity as were lower symptoms of depression and anxiety.

Previous examinations of physical activity and mental health found statistically significant but small differences between more and less active adolescents, particularly for depression and anxiety (McMahon et al., 2017) that may not be clinically meaningful. Our findings, however, suggest more meaningful differences in depression and anxiety from increases in physical activity for both males and females, particularly as they move from the Least Active to Somewhat Active groups. These findings are consistent with longitudinal research on the association between increases in wellbeing and frequency (Wang et al., 2012). Outside of gender and team sport, the Least Active and Somewhat Active groups accounted for the largest differences in mental health outcomes. This is consistent with previous findings in both adolescents (McMahon et al., 2017) and adults (de Souto Barreto, 2015). These findings suggest that even a slight increase in physical activity may confer significant benefits for mental health while also emphasising the message that key policy aims should be targeted at those who are fully inactive, or least active, with a view to improving the mental health of those most in need (Vancampfort, Stubbs, Ward, Teadale & Rosenbaum, 2015).

The greatest difference in terms of all mental health outcomes was between those who played sport, either 1, 2 or 3+, and those who didn't. Participation in team sport conferred an additional mental health benefit. Previous investigations into physical activity and mental health measures failed to take into account the nature or type of activity which may account for the smaller effect sizes (Strong et al., 2005; Biddle & Asare, 2011; Biddle et al., 2019). Our findings on team and individual sport, and the number of sports played, helped to identify the context of activity which may provide the greatest support to improvements in mental health. Highest levels of wellbeing and lowest levels of depression and anxiety were found in those who played team sport compared to individual or no sport. Highest levels of wellbeing and lowest levels of depression and anxiety were also found in those who played 3+ sports, with wellbeing increasing, and depression and anxiety decreasing, the more sports that are played. McMahon et al., (2017) also found significant differences in wellbeing, depression and anxiety for females although not in males. Our findings suggest that team sport confers significant mental health benefits for males and females, regardless of frequency of activity. Vella et al. (2020) have suggested that high levels of self-determination and enhanced social identification among youth sport players could provide extra benefits for mental health.

Investigations involving adult populations found associations between greater mental health outcomes and higher frequencies of physical activity, with particularly low and particularly high thresholds of activity associated with lower levels of mental health, especially in females (Kim et al., 2012). It has previously been suggested that some sub-groups engaging in high frequency or daily activity may include adolescents who over-exercise or suffer from potential eating disorders (Smith et al., 2013; Davis et al., 1997). This does not appear to be the case among our particular cohort as wellbeing continued to increase with a higher frequency of activity in both males and females, while anxiety and depression continued to decrease for females and reached a plateau in males from 10–14 days for depression, and 8–14 days for anxiety. This suggests there may be an optimal range of physical activity for mental health benefits, although with no major negative effects of going above this in terms of mental health outcomes.

A number of mechanisms have been suggested to explain the positive relationship between wellbeing and physical activity, and the inverse relationship between physical activity and anxiety and depression (Stavarakakis, de Jonge, Ormel & Oldehinkel, 2012). Most recent evidence suggests a combination of physiological and psychosocial processes. Proposed physiological mechanisms, such as the *monoamine hypothesis* (exercise improves brain aminergic synaptic transmission, affecting monoamines such as noradrenaline, dopamine, BDNF, and serotonin, all of which have been implicated in depressive disorders) (Ransford, 1982; Chen, 2013); the *endorphin hypothesis* (endorphins are produced as a result of exercise, which help to reduce pain and induce a state of euphoria) (North & McCullagh, 1990; Morgan, 1985); and the *anterior cingulate cortex hypothesis* (which can be developed through a higher frequency of moderate exercise and is believed to lead to an increase in grey matter volume) (Lin et al., 2020; Lubans et al., 2016; Phillips & Swartz, 2014) cannot entirely account for physical activity induced changes in mental health. Meta-analytic evidence has shown a positive association between leisure-time physical activity and mental health. Positive associations between transport-related physical activity and mental health in adults have also been found, although the relationship is less clear in adolescents (White et al., 2017). Work-related or occupational-based physical activity is associated with negative mental health outcomes (White et al., 2017). These domain-specific differences in the association with mental health suggests that the association between physical activity and mental health is not purely because of physiological mechanisms (Teychenne et al., 2020). Therefore, other

factors relating to physical activity experience, such as psychosocial mechanisms, need to be considered. These other factors include mastery of goals/skills, autonomous motivation, enjoyment, choice, a sense of belonging, and social interaction (Biddle & Mutrie, 2007; White et al., 2018); all of which are associated with playing sport, and team sport in particular. Physical activity performed outdoors has also been associated with lower incidences of mental ill-health than exercise performed indoors. As the most popular sports in Ireland (gaelic football, hurling and soccer) are performed outdoors, this may also explain the higher levels of wellbeing in adolescents who participate in team sport. Based on the proposed mechanisms by which physical activity improves mental health, our findings support recent recommendations that guidelines for mental health benefits should also include a context as well as frequency, intensity, type and time (Teychenne et al., 2020).

Limitations of this study include the use of a self-report questionnaire to measure frequency of physical activity, which may be prone to recall bias and varying interpretations of physical activity in different genders and ages (Hallal et al., 2012). Cross-sectional studies of this nature do not allow for the investigation of any causal or temporal relationships between mental health outcomes and the frequency or context of physical activity. Further research could include longitudinal examinations of how mental health outcomes track throughout post-primary school and into young adulthood and the impact of physical activity on later mental health. The use of previously validated measurement tools and a large sample of Irish adolescents are strengths of the study.

## Conclusion

Approximately one third of adolescents fall outside the normal range for depression and anxiety with females and other having a higher prevalence than males. Depression and anxiety levels increase in adolescents after 1<sup>st</sup> year and are at their highest in the years that conclude with state exams. Regular engagement in physical activity is associated with greater wellbeing, and lower depression and anxiety in young people. These findings emphasise the importance of increasing physical activity levels among adolescents who are least active. Engagement in sport, and team sport in particular, confers additional benefits over and above that provided by activity alone. Future physical activity recommendations for children and adolescents should include mental as well as physical health benefits. The provision of a wider variety of physical activities and sports through school and community organisations should be a priority for the optimal development of physical and mental health among adolescents. Future school and community-based interventions should focus on increasing the frequency of exposures to physical activity and increasing engagement and retention of young people in individual or team sports to promote wellbeing and positive mental health in adolescents.

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## Competing Interests

The authors have no competing interests to declare.

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