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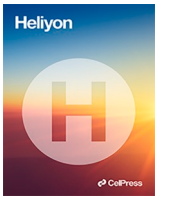

Research article

Quantifying physical activity, physical education and active travel in children and adolescents with visual Impairments

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A B S T R A C T

Background: Meeting the physical activity (PA) guidelines for children, as set out by the World Health Organisation (WHO), has a range of physical and mental health benefits. For children who are blind or vision impaired (BVI), additional benefits include social inclusion and reduced falls risk. While previous research has demonstrated low PA levels across most demographics, little research has been done in the Irish context to quantify PA in children who are BVI. Two potential methods of increasing PA levels, active travel (AT) and physical education (PE), have additionally never been assessed in this group.

Methods: Consenting parents of children who are BVI (n = 53, 55 % boys, mean age of children 12.92 ± 2.76 years) completed a questionnaire regarding PA levels, and participation in AT and PE.

Results: PA levels were low, with 9.6 % achieving WHO guidelines (60 min MVPA/day). There was no statistically significant differences between genders completing either no PA in the last week ($p = 1.00$) or MVPA on each of the last 7 days ($p = 0.157$). 14.4 % used AT to get to school. Mean PE times in minutes/week were lower than the general population (58.63 min), with a low proportion of respondents meeting PE guidelines (32.1 %). Regarding barriers to PA, 17.0 % of respondents stated they were very likely to be "too tired after school to be active". 13.5 % stated they were very likely to feel "my day is so busy now I just do not think I can make time to include PA in my regular schedule".

Conclusion: This study provides a valuable insight into the low levels of PA that prevail amongst BVI children. Increasing PA levels would provide individual benefits (including physical and mental health benefits) as well as population benefits (including reduced health expenditure). Future qualitative research should seek to gain a deeper understanding of the PA barriers, motivators and facilitators in this cohort.

1. Background

Physical activity (PA) is essential in the prevention of non-communicable diseases such as diabetes, dementia and certain forms of cancer [1]. Furthermore, strong positive correlations between PA levels and mental health have also been demonstrated in youths [2]. It therefore seems logical that all factors that increase PA participation in children and young people should be explored in an effort to positively impact their health. Physical education (PE) and active travel ((AT; defined as walking or cycling for the purpose of functional rather than leisure travel) have been recognised as key areas where children and young people can increase their level of PA [3–5].

The World Health Organisation (WHO) recommends an average of 60 min of moderate to vigorous physical activity (MVPA) per day for children and adolescents aged 5–17 years, with an additional emphasis on muscle strengthening at least three times per week [6]. In the paediatric population, both national and international data suggests that the majority of children are not sufficiently

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physically active to elicit the positive health benefits associated with PA [7,8]. Research suggests that those with a disability have even lower levels of PA, with Longmuir & Bar-Or (1994) identifying a statistically significant increase in sedentary lifestyle amongst the population with a disability [9]. Specifically, those with a vision impairment (VI) were at even higher risk of low PA than those with other impairments such as a physical disability or a hearing impairment [9].

The relationship between engagement in PA and VI is complex, and recent research has sought to shed light on the interplay between the two. While the health risks for low activity levels are well documented [1] in the population with VI, a lack of PA and the resulting higher BMI increases the incidence of sight threatening metabolic diseases, including diabetic retinopathy, glaucoma and macular degeneration [10–12], the consequences of which would be greater for those who already experience poor vision. Given the strong correlation between PA levels in childhood and adulthood, improving PA levels in childhood and adolescence offers a unique opportunity to provide long term benefits to this group [13,14].

While information regarding PA levels in children and adolescents who are blind or vision impaired (BVI) can be accessed either through filtering the results of large population based surveys [8,15] or studies conducted on those with multiple different types of disability [9,16], limited studies have attempted to quantify levels of PA specifically for young people who are BVI. Haegele and Poretta's review (2015), for example, identified 18 studies published over a 32 year period on the topic, providing evidence of lower PA levels in children who are BVI while also identifying the need for further research regarding the variables that influence PA [17]. The barriers to PA in this population are known to be unique and difficult to overcome [17,18]. Linsenbigler's 2018 review, spanning over 30 years of research from 1984 to 2015, highlighted the persistence of social barriers such as attitudes about visual impairments, and lack of professional training [19]. Additional environmental barriers such as access to appropriate equipment and suitable transport have been highlighted in both Linsengbigler's (2018) review [19] and similar research [20].

AT, traditionally defined as walking and cycling for the purpose of functional rather than leisure travel, is a recent area of Irish government policy focus, forming part of the government's National Sustainable Mobility Policy [5,21]. If implemented successfully, policies such as this should lead to increased PA for the entire population. AT has long been recognised as positively contributing to overall PA, through the provision of mobility and activity that is easily accessible and affordable [4,22]. According to Götschi (2015), adoption of high levels of AT could prevent up to 4 % of all cause deaths [4]. AT, however, presents unique difficulties to the BVI population. While the Royal National Institute for Blind People (RNIB) in the UK highlighted the importance that 90 % of respondents who are BVI placed on the ability to make walking journeys independently [23], obstructions such as cluttered pavements, lack of accessible pedestrian crossings and difficulty detecting quiet/silent electric vehicles have been identified as barriers to AT for this population. Additionally, in a survey of Irish people experiencing BVI, up to 63 % of respondents to a recent survey had been injured while walking in their local area [24], resulting in the need for campaigns such as the Vision Ireland's recent 'Clear Our Paths' [25]. Assessment of the current levels of AT within the BVI population in Ireland is needed, not only to raise further awareness of the importance of AT but also to provide a baseline from which the impact of future interventions can be judged.

While it is clear that AT is a key determinant for increasing PA levels, children and adolescents spend the majority of their waking hours in school, and education settings provide another opportunity to increase PA levels and sports specific skills [3]. The Department of Education in Ireland recommends that all primary school students in Ireland receive at least 60 min of PE weekly, and all post-primary schools receive either a double class or 80 min/week [26,27]. PE guidelines in Ireland do not make any specific accommodations for those with a disability, including those who are BVI. As a result, additional efforts should be made to ensure these students meet these guidelines. For the BVI, PE additionally offers opportunities to develop self-determination skills (the ability of individuals to make choices and have control over their lives) and sensory efficiency skills (use of residual vision, hearing and other sense to enhance access to the environment) – key skills that will likely serve as building blocks for future PA [28]. Evidence shows, however, that the inclusion of children who are BVI can be challenging for teachers, leaving these children at risk of reduced access to PE [29–31].

Given that PA levels have not been quantified in the Irish BVI population to date, assessing current PA levels is vital to understanding whether interventions to increase PA in youths with BVI in Ireland are needed. In addition, information on barriers/enablers of PA, use of AT and participation in PE amongst this cohort, particularly in the Irish context, will provide essential information that is required to direct any necessary changes in policy.

1.1. Study aim

The aim of this study was to further investigate PA levels of children and adolescents who are BVI in Ireland, as well as the barriers and motivators to PA this group experience, an area which is yet to be studied in the Irish context. To further understand PA levels in this group, this research also aimed to quantify AT and engagement in PE class – unique insights which have not been obtained in an Irish or international context.

The impact of gender on PA levels is unique in the BVI population, with Kozub et Oh (2004), for example identified no difference in PA levels between genders [32], unlike the general population [13]. To explore this aspect in the Irish context, analysis will be conducted to investigate the impact of gender on PA levels within this population.

1.2. Study design and methods

A cross sectional survey design investigating PA levels and related variables was selected as an appropriate method of investigation. Quantitative online surveys were selected as the most effective data collection tool given the practicality, cost effectiveness and ease of collection and distribution across the country [33]. They are useful when classifying activity levels (sufficient/insufficient,

low/moderate/high), providing information regarding different types of PA and showing changes between groups, given their accuracy on a population level [33,34]. Based on previous research with this cohort, and in consultation with research partners Vision Sports Ireland (VSI) (the national governing body for sport and leisure opportunities for people who are BVI in Ireland) [35], MS Forms was selected as the most user-friendly and accessible online platform from which to collect questionnaire-based data in this sample [36].

The majority of questions included in the questionnaire were based on the Children Sports Participation and Physical Activity Questionnaire (CSPPA) 2022 [27]. CSPPA is a 170+ item questionnaire conducted at 4–5 yearly intervals following first iteration in 2005. This all-island research study of children age 10–18 includes topics relating to PE, PA and AT. Validity has previously been established through previous CSPPA iterations [27]. The instruments selected for CSPPA 2022 were based on developmentally appropriate and psychometrically valid self-report instruments, which are provided in Table One [27,37–39]. Gender was determined by self-report, consistent with CSPPA [27]. Modifications were made where required to ensure the survey was appropriate for the cohort. One modification was required, specifically adding "with the use of a mobility aid" when assessing mobility challenges. An additional demographic question was added to clarify the level of vision impairment as per the Paralympics Ireland and the International Paralympic Committee [40,41]. These changes were primarily suggested by representatives of VSI, and agreed by consensus with the research team. A pilot version of the survey was trialled with volunteers who were BVI and feedback was sought to ensure the highest levels of accessibility and acceptability. No adjustments were required at this point.

Barriers to PA identified by the children who completed the survey were identified as responses to six questions, with respondents being asked to rate their likelihood of agreeing with that sentence on a four point scale from very likely to very unlikely. This was consistent with methods used in the CSPPA study [27]. Data regarding PE and AT was also obtained through questions previously validated in the CSPPA study [27]. The evidence base for specific survey questions can be found in Table 1.

1.3. Participants

Participants were recruited through an extensive social media campaign and events run by VSI, Vision Ireland, and other community organisations, to ensure participants were not solely those who are in contact with VSI and regularly participate in sports. Inclusion criteria consisted of individuals aged 18 and under with a VI. VI was classified as per the Paralympics Ireland and International Paralympic Committee (IPC) classification system [40,41]. Exclusion criteria included those over 18, or those whose parent/guardian was unable to complete the survey with them. Parents provided demographic information as well as background details regarding level of VI, school level, school type and additional supports required, before the children completed questions regarding PA levels, PE class, AT, PA barriers and PA motivators.

1.4. Consent and ethical approval

Ethical approval was obtained from the institutional Research Ethics Committee (DCU/REC/XXXX). Consent was obtained from parents/guardians prior to beginning the survey, with detailed information regarding the processes involved available through an accessible digital document. Plain language videos with audio descriptions explaining the nature of the research were also recorded by the research team to maximise accessibility to participants. Parents were advised to complete an initial portion of the survey before sharing the device with their child, ensuring that both the parent and child data were submitted simultaneously and as a single response. Assent was provided by the children completing the survey through tick box on survey initiation and again prior to the final

Table 1
evidence base for questionnaire.

Subject of Interest	Question asked	Reliability	Source
Level of Vision Impairment	What level of vision does your child have? - no vision (B1 – no perception of light) - low vision (B2 – can you see hand movements, counting fingers) - useful vision (B3–B5 – better than 6/60 with a visual field constriction of less than 40°).	n/a	(International Paralympic Committee, 2019)
PA levels	Mean of; i) Over the past 7 days on how many days were you physically active for a total of 60 min per day? ii) Over a typical or usual week, on how many days are you physically active for a total for a total of 60 min per day?	Intraclass correlation, 0.77; Correlation with accelerometer data ($r = 0.40$, $P < 00.001$)	(Prochaska et al., 2001)
Participation in muscle strengthening exercises	During the last 7 days, on how many days did you do exercise that may strengthen your muscles, such as push-ups, sit-ups, weight lifting or heavy yard work?	n/a	(Woods et al., 2022)
Rates of active travel	How do you usually travel i) to school, ii) from school?	n/a	(Woods et al., 2022)
Walkability of local area	Overall, how would you rate your neighbourhood as a place to walk? Walkable means pedestrian friendly.	n/a	(Woods et al., 2022)
Barriers to PA	6 item screening tool with responses very unlikely, somewhat unlikely, somewhat likely and very likely to respond to suggestions such as; My day is so busy now I just do not think I can make the time to include physical activity in my regular schedule	n/a	(Woods et al., 2022)

third of the survey, after the information deemed most essential was identified. Only those who returned completed consent forms were eligible for inclusion in the study. Each parent/child pair was assigned a unique numerical code to ensure anonymity.

1.5. Data processing

Data regarding PA levels were obtained through the average of two questions, where participants were asked about the number of days in which they achieved 60 min of MVPA in the last week and over a typical or usual week, as per Prochaska et al. (2001) protocol [39].

Adherence to PE guidelines was assessed through ascertaining the number of minutes of PE class each respondent participated in over the last week, as well as the class/year the respondents were in, and comparing this information to national curriculum guidelines based on school stage [26,27].

AT data was obtained through two questions regarding journeys to school and from school, with children asked to select the most regularly used transport method for the longest portion of their journey. This method was previously validated through the CSPPA study [27]. As per the 2022 iteration of the CSPPA study, AT data was reported as children either walking or cycling to or from school [27]. Data regarding barriers and enablers for PA was provided through multiple-response questions, also as per CSPPA 2022 [27].

1.6. Data analysis and statistical methods

Data analyses were performed using SPSS software version 28. Descriptive statistics and frequency tables were produced to determine demographic data, mechanism of transport to school (i.e. use of active transport) and the number of days in the last week during which children completed 60 min of MVPA. Descriptive statistics were also used to report frequency of barrier data identified.

Data is presented as mean ± standard deviation unless otherwise stated. An independent-samples *t*-test was run to determine if there were differences in PA levels (days/week where 60 min MVPA was achieved) between boys and girls.

Fischer exact testing was used to assess for associations between gender and meeting PE guidelines. In each of these cases greater than 20 % of cells had expected counts of less than 5. Kendall's tau-b testing was used as a nonparametric measure of strength and direction of association between gender and participation in muscle strengthening activities. Chi-square test for independence was used to examine the relationship between gender and meeting WHO guidelines regarding muscle strengthening exercises, where greater than 20 % of cells had expected counts of greater than five. All expected cell frequencies were greater than five.

Information regarding PE was obtained as per CSPPA, and compared to local guidelines available at time of publication [42].

2. Results

Fifty-three parent/guardian and child pairs completed the survey (55 % boys, mean age of children 12.92 ± 2.76 years, range 9–18). Distribution in terms of area of residence, type and level of school and level of VI are described in Table 2. 9.6 % of respondents completed 60 min of MVPA on each of the last seven days. 7.7 % had not completed 60 min of MVPA on any day, with 30.7 % completing 60 min MVPA less than 3 days a week.

With regard to gender, 10.3 % (3/29) of boys and 8.7 % (2/23) of girls achieved 60 min of MVPA on each of the last seven days. There was no statistically significant association between gender and completing seven days of MVPA as assessed by Fisher's exact ($p = 1.00$). 1/29 boys (3.4 %) and 4/23 (17.4 %) girls had no PA in the previous seven days. There was no statistically significant association between gender and completing no MVPA in the last seven days by Fisher's Exact ($p = 0.157$). Additionally, with regard to muscle strengthening exercises, 14/29 boys (48.3 %) and 6/23 girls (26.1 %) met the WHO muscle strengthening guidelines of incorporating muscle and bone strengthening activity at least 3 days a week [6]. A chi square test for association showed no statistically significant association between gender and meeting the muscle strengthening guidelines (χ^2 [1] = 2.668, $p = 1.02$) (see Fig. 1).

Table 2
Demographic Data.

	Subcategory	N	%
Gender	Boy	29	54.70 %
	Girl	23	43.40 %
Area of residence	Village/Rural area (<3000 inhabitants)	26	49.10 %
	Town (<20,000 inhabitants)	6	11.30 %
	Suburbs/large town/Outskirts of city (<70,000 inhabitants)	15	28.30 %
	A big city (>70,000 inhabitants)	6	11.30 %
Type of school	Mainstream school	45	84.90 %
	Special school	2	3.80 %
	School tailored for students with VI	4	7.50 %
	Other	2	3.80 %
Level of schooling	Primary/Junior school (approx. age <12 years)	16	30.20 %
	Secondary school (approx. age >12 years)	37	69.80 %
Level of VI	No Vision (B1)	6	11.30 %
	Low Vision (B2)	12	22.60 %
	Useful Vision (B3–B5)	35	66.0 %

Barriers to PA are reported in Fig. 2. When asked about the barriers to PA, 17.0 % of respondents stated they were very likely to be "too tired after school/work to be active", while 13.5 % stated they were very likely to feel "my day is so busy now I just do not think I can make time to include PA in my regular schedule". Concern regarding injury was relatively low with 51.9 % citing this as very unlikely to be a barrier to PA.

The use of AT (i.e. walking or cycling to school) [42] is reported in Table 3, where 14.4 % used active transport on their route to school.

Regarding PE, mean time in PE class was 58.6 min/week, lower than mean of 85 min/week and 73 min/week in the general population at primary and secondary school respectively [27]. Additionally, the proportion of children who are BVI meeting Department of Health PE Guidelines (60 min/week at primary school level and 120 min/week at secondary school level) was lower than the general population. 53.1 % of BVI respondents at primary level met PE Guidelines, vs 72 % of the general population studied at CSPPA [27]. Results were more stark at secondary school level, with 11.1 % vs 72 % of the general population [27].

3. Discussion

This is the first study of its kind to quantify PA levels of children and adolescents who are BVI, and as such provides unique insights into the motivators and barriers to PA. Perhaps the most stark result emerged in the area of PA levels, with just 9.6 % achieving the target of 60 min MVPA/day (vs 15.4 % in the sighted population) [27] and half the BVI cohort engaging in 60 min MVPA less than four days a week. Possible explanations for this include the low proportion engaging in AT to school (14.4 % vs 35–45 % of the general population) and meeting national PE guidelines (32.1 %. vs 72–75 % of the general population, depending on school level). Barriers to PA were varied with tiredness proving to be quite regularly cited as very likely to prevent PA (17.0 %) and fear of injury, by comparison, cited as a very likely barrier less frequently (1.9 %). Given the long term impact of low levels of PA on physical and mental health, and the noted environmental benefits of AT, this is not a sustainable situation at an individual or population level [1,43,44].

Of particular concern was the low level of children achieving 60 min of MVPA seven days a week, with just 9.6 % reaching this target. While the WHO states that this can be achieved as an average over seven days, given the comparatively low numbers achieving 6 or more days a week (13.4 %) and the high proportion completing 60 min MVPA on four days a week or less (50.0 %), it seems very likely that the vast proportion of our participants are not meeting WHO guidelines [6]. The discrepancy between PA levels and the general population is perhaps not as stark as expected. In CSPPA's most recent 2022 results report, similar to the cohort in this study, only 15 % achieved 60 min of MVPA per day [27]. Those with a disability who completed CSPPA were also less likely to complete 60 min of MVPA a day (12 % vs 16 % with no disability), though the definition of disability used in CSPPA originated in the UNICEF Child Functioning tool, and includes physical, sensory and functional disabilities including VI [45]. In addition to MVPA, the WHO has recently recommended the inclusion of muscle strengthening exercises which should occur three times a week [6]. Almost two thirds of respondents to this questionnaire were not adhering to these guidelines – similar to the general population assessed in CSPPA (57 %) [27]. Whilst certainly not as low as overall PA levels, conditioning and muscle strengthening exercises should be an additional target for future interventions.

While overall levels of PA were low, the lack of discrepancy between genders was interesting to note, given that this appears to be a feature unique to the BVI population. Large multinational research studies have demonstrated statistically significant differences between genders in the general population, with boys being more physically active than girls [7]. These differences become even more pronounced with age, with the gap between boys' and girls' activity levels increasing in the mid to late teenage years [7,27]. Similar discrepancies exist with regard to muscle strengthening activities, with men being more likely than women to participate in muscle strengthening activities in sixteen studies across six countries [46]. In our BVI cohort, there was no statistically significant difference

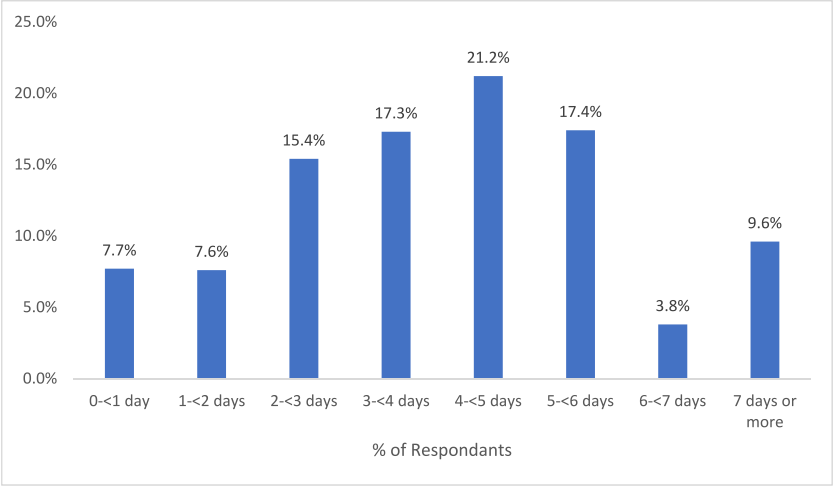

Fig. 1. Days per week with 60 min of Moderate to Vigorous Physical Activity completed by children who are Blind or Vision Impaired.

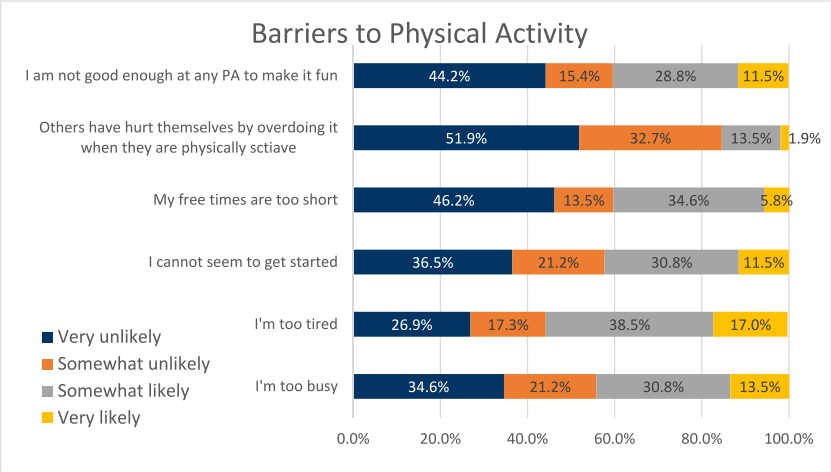

Fig. 2. Barriers to Physical Activity reported by children who are Blind and Visually Impaired.

Table 3
Chosen mechanism of transport to school.

Mechanism of Transport	Activity Status;	Frequency (n = 52)	%
Car	Inactive	21	30.4 %
Bus	Inactive	23	44.2 %
Bicycle	Active	1	1.9 %
By Foot	Active	7	12.5 %

between girls and boys meeting PA guidelines (daily 60 min MVPA). Additionally, there was no statistically significant difference between the genders of those who participated in muscle strengthening exercise. One possible explanation for this may be the low numbers of participants engaging in muscle strengthening exercises to begin with (42.3 % of respondents do not participate in any muscle strengthening exercises at all). Previous studies, though smaller in participant number, demonstrated similar findings with regard to PA levels in the population who are BVI, with no significant difference between PA levels found [32,47]. The findings regarding muscle strengthening activities in our cohort were, to the best of our knowledge, unique. Together, these findings provide further weight to Marmeleira's postulation that the lower level of PA in this groups attenuates the impact of differences between the genders [48]. Given these low PA levels all factors that could positively impact PA participation rates should be explored. Considering the proportion of time children spend in school, AT [5,44,49] and PE class [50] have previously been identified as possible opportunities for intervention.

Given its low cost and accessibility to different age groups, AT is a potentially easy target for increasing PA levels [44,49]. The use of AT to school is disappointingly low in our survey, with 14.4 % of respondents commuting to school either by bike or foot (vs 37 % of the general population [27]). Taking into account the environmental as well as health benefits of AT, and the fact that 56.9 % of respondents rated their local area as either somewhat or very walkable, this represents a significant opportunity for intervention and a target for public health intervention. It was interesting to note additionally that 50 % of respondents lived within 5 km of their school. It would also align with the current National Sustainable Mobility Policy in Ireland [21], and similar policies in other countries such as the European Union's Sustainable Urban Mobility plan [51], and the UK's "Gear Change" policy [52]. Campaigns such as 'Clear our Paths' run by Vision Ireland are an illustration of some of the infrastructure changes that may be required to increase this number [25].

Increasing the offering of PE in schools may prove to be an area which can elicit the most benefit in targeting increased PA amongst BVI children. PE provides an opportunity for children who are BVI not only to participate in PA, but additionally provides them with the skills necessary to adapt any sports/PA they may have an opportunity to participate in the future [30,53]. Unsurprisingly there are unique barriers to including children who are BVI in PE lessons [30,31], particularly given that the majority of children who are BVI in Ireland attend mainstream school. Unfortunately the proportion of children meeting PE guidelines in this study was quite low at 32.1 %, with a mean time of 58.63 min/week – significantly lower than their sighted counterparts where 72–75 % of children meet the PE guidelines [27]. In an attempt to understand the reasons for this discrepancy, participants were asked to select reasons as to why they did not participate. The most common reasons cited were due to "participation in other activities" (33.3 %), being "unable" to participate (33.3 %), and worryingly, "parents or teachers prefer I sit out PE" (16.7 %). Given the majority of these children are attending main stream school, it is difficult to ascertain what other activities are being prioritised over PE though possibilities include access to resource hours. While further research is required to understand these barriers in greater detail, these results demonstrate a need to prioritise PE class in school and adapt PE activities to meet the needs of the child such that they are able to participate fully [30,54].

3.1. Strengths and limitations

Strengths of this study include its use of previously well validated tools including Prochaska's PACE + questionnaire [39] and CSPPA [27]. The short term recall nature of the questionnaire [55] was used in an attempt to reduce recall bias. The limitations of this study include the use of questionnaires to collect data. Questionnaires are at risk of social desirability bias, whereby participants seek to provide the perceived "correct" responses [33,56]. The use of VSI's social media pages may also be seen as a potential weakness, given that they are more likely to be accessed by families already seeking opportunities to engage in PA. This weakness however was balanced through the use of Vision Ireland's social media – a support service for people who are BVI which has a broader focus than specifically sport. Despite this the levels of PA remain worryingly low, suggesting that levels of PA in the BVI cohort may be even lower than demonstrated in this study.

4. Conclusion

Establishing healthy, lifelong habits is particularly important in childhood and adolescence, with studies suggesting that adolescents who participate in PA are more likely to become physically active adults [13,14]. The low PA levels in the cohort captured by this research should now serve as a benchmark to assess the effectiveness of any future interventions. PE classes and AT are two mechanisms through which improvements in PA levels can be made and represent areas that should be targeted in future interventions. Further studies, however, are required to better understand the causes of perceived barriers to and motivators for PA in this group. Qualitative studies may enable a deeper understanding of the experiences behind these low PA levels.

Data availability

Regarding data availability, we regret that we are unable to deposit our dataset into a publicly available repository. The primary reasons for this decision are as follows.

- Participant Age and Sensitivity: Our dataset includes information from participants who are under the age of 18. Due to the sensitive nature of the data involving minors, it is critical to maintain strict confidentiality to protect the participants' privacy and well-being.
- Lack of Consent for Data Sharing: During the data collection phase, we did not obtain explicit consent from the participants or their guardians for sharing the data publicly. As a result, making the dataset available would violate ethical guidelines and the assurances of confidentiality given to the participants.

We recognise the importance of data sharing and are committed to ensuring that our research findings are transparent and reproducible. Although we cannot share the raw data, we are open to providing detailed summaries, statistical analyses, and any other relevant information that can help other researchers evaluate and build upon our work. Researchers with specific queries or who require further details are welcome to contact us directly, and we will do our best to assist them within the constraints of ethical and privacy considerations.

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CRediT authorship contribution statement

Lisa Flynn: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Kristina Millar:** Writing – review & editing, Resources, Methodology, Conceptualization. **Sarahjane Belton:** Writing – review & editing, Visualization, Funding acquisition, Data curation, Conceptualization. **Noel O'Connor:** Funding acquisition, Conceptualization. **Sarah Meegan:** Writing – review & editing, Conceptualization. **Una Britton:** Writing – review & editing, Supervision. **Stephen Behan:** Writing – review & editing, Supervision, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] D.E.R. Warburton, C.W. Nicol, S.S.D. Bredin, Health benefits of physical activity: the evidence, CMAJ (Can. Med. Assoc. J.) : Can. Med. Assoc. J. 174 (6) (2006 Mar 3) 801 [cited 2022 Oct 17] /pmc/articles/PMC1402378/.

[2] S.A. Paluska, T.L. Schwenk, Physical activity and mental health: current concepts, Sports Med. 29 (3) (2000) 167–180, cited 2022 Oct 10, https://pubmed.ncbi.nlm.nih.gov/10739267/.

[3] A. Grao-Cruces, V. Segura-Jiménez, J. Conde-Caveda, L. García-Cervantes, D. Martínez-Gómez, X.D. Keating, et al., The role of school in helping children and adolescents reach the physical activity recommendations: the UP&DOWN study, J. Sch. Health 89 (8) (2019 Aug 1) 612–618 [cited 2023 Aug 23], https://onlinelibrary.wiley.com/doi/full/10.1111/josh.12785.

[4] T. Götschi, M. Tainio, N. Maizlish, T. Schwanen, A. Goodman, J. Woodcock, Contrasts in active transport behaviour across four countries: how do they translate into public health benefits? Prev. Med. 74 (2015 May 1) 42 [cited 2023 Aug 21] /pmc/articles/PMC4456468/.

[5] R. Larouche, G. Faulkner, M.S. Tremblay, Health reports active travel and adults' health: the 2007-to-2011 Canadian health measures surveys [cited 2023 Aug 21]; Available from, www.statcan.gc.ca, 2016.

[6] World Health Organisation, WHO Guidelines on Physical Activity and Sedentary Behaviour, 2020.

[7] P.C. Hallal, L.B. Andersen, F.C. Bull, R. Guthold, W. Haskell, U. Ekelund, et al., Global physical activity levels: surveillance progress, pitfalls, and prospects, Lancet 380 (9838) (2012) 247–257 [cited 2022 Oct 25], https://pubmed.ncbi.nlm.nih.gov/22818937/.

[8] C.B. Woods, C. Powell, J.A. Saunders, W. O'Brien, M.H. Murphy, C. Duff, et al., The Children's Sport Participation and Physical Activity Study 2018, 2018.

[9] P.E. Longmuir, O. Bar-Or, Physical activity of children and adolescents with a disability: methodology and effects of age and gender, Pediatr. Exerc. Sci. (2) (1994 May 1) 168–177.

[10] O. Mbata, N.F.A. El-Magd, A.B. El-Remessy, Obesity, metabolic syndrome and diabetic retinopathy: beyond hyperglycemia, World J. Diabetes 8 (7) (2017 Jul 7) 317 [cited 2023 Mar 16] /pmc/articles/PMC5507828/.

[11] N. Cheung, T.Y. Wong, Obesity and eye diseases, Surv. Ophthalmol. 52 (2) (2007 Mar 1) 180–195.

[12] K.K. Snow, J.M. Seddon, Ophthalmic Epidemiology Do age-related macular degeneration and cardiovascular disease share common antecedents? [cited 2023 Mar 31]; Available from: https://www.tandfonline.com/action/journalInformation?journalCode=iope20, 2009.

[13] R. Telama, Tracking of physical activity from childhood to adulthood: a review, Obes. Facts 3 (2009) 187–195 [cited 2022 Nov 1].

[14] R. Telama, X. Yang, J. Viikari, I. Välimäki, O. Wanne, O. Raitakari, Physical activity from childhood to adulthood: a 21-year tracking study, Am. J. Prev. Med. 28 (3) (2005) 267–273 [cited 2022 Nov 1], https://pubmed.ncbi.nlm.nih.gov/15766614/.

[15] L. Smith, S.E. Jackson, S. Pardhan, G.F. López-Sánchez, L. Hu, C. Cao, et al., Visual impairment and objectively measured physical activity and sedentary behaviour in US adolescents and adults: a cross-sectional study, BMJ Open 9 (4) (2019 Apr 1) [cited 2022 Dec 5], https://pubmed.ncbi.nlm.nih.gov/30987991/.

[16] P.E. Longmuir, O. Bar-Or, Factors influencing the physical activity levels of youths with physical and sensory disabilities, Adapted Physical Activity Quarterly [Internet] 17 (1) (2000 Jan 1) 40–53 [cited 2022 Aug 29], https://journals.humankinetics.com/view/journals/apaq/17/1/article-p40.xml.

[17] J.A. Haegele, D. Porretta, Physical activity and school-age individuals with visual impairments: a literature review, Adapt. Phys. Act. Q. (APAQ) : Adapt. Phys. Act. Q. (APAQ) 32 (1) (2015 Jan) 68–82.

[18] K.R. Allison, J.J.M. Dwyer, S. Makin, Perceived barriers to physical activity among high school students, Prev. Med. 28 (6) (1999 Jun 1) 608–615.

[19] K. Linsenbigler, S. Petersen, L.L. Palaestra, undefined. Barriers to physical activity for children with visual impairments: how far have we come and where do we still need to go? researchgate.netK Linsenbigler, S Petersen, L LiebermanPalaestra, 2018•researchgate.net [Internet] 2018 (2018) [cited 2023 Aug 21]; Available from: https://www.researchgate.net/profile/Lauren-Lieberman/publication/330026120_BARRIERS_TO_PHYSICAL_ACTIVITY_FOR_CHILDREN_WITH_VISUAL_IMPAIRMENTS_HOW_FAR_HAVE_WE_COME_AND_WHERE_DO_WE_STILL_NEED_TO_GO/links/5c2a6912299bf12be3a46090/BARRIERS-TO-PHYSICAL-ACTIVITY-FOR-CHILDREN-WITH-VISUAL-IMPAIRMENTS-HOW-FAR-HAVE-WE-COME-AND-WHERE-DO-WE-STILL-NEED-TO-GO.pdf.

[20] E.A. Jaarsma, R. Dekker, P.U. Dijkstra, J.H.B. Geertzen, S.A. Koopmans, Barriers to and facilitators of sports participation in people with visual impairments, Adapted Physical Activity Quarterly [Internet] 31 (3) (2014 Jul 1) 240–264. Available from: https://journals-humankinetics-com.dcu.idm.oclc.org/view/journals/apaq/31/3/article-p240.xml.

[21] Department of Transport, National Sustainable Mobility Policy Action Plan 2022-2023 [Internet], Government of Ireland, Dublin, 2022. Available from:.

[22] C.L. Craig, A.L. Marshall, M. Sjöström, A.E. Bauman, M.L. Booth, B.E. Ainsworth, et al., International physical activity questionnaire: 12-country reliability and validity, Med. Sci. Sports Exerc. 35 (8) (2003 Aug 1) 1381–1395 [cited 2022 Nov 1], https://europepmc.org/article/med/12900694.

[23] Walking and Cycling Alliance, Pave the Way, 2020.

[24] F.E.Z. El-Taher, L. Miralles-Pechuán, J. Courtney, K. Millar, C. Smith, S. Mckeever, A survey on outdoor navigation applications for people with visual impairments, IEEE Access 11 (2023) 14647–14666.

[25] National Council for the Blind of Ireland, Clear our Paths [cited 2024 Mar 4]; Available from: https://www.independent.ie/irish-news/revealed-the-counties-that-issued-most-fines-for-parking-on-footpaths-and-dog-fouling/a771592513.html, 2023.

[26] Department of Education (An Roinn Oideachais), Junior Cycle Physical Education Curriculum Specification, 2022.

[27] C.B. Woods, K.W. Ng, U. Britton, J. McClelland, A. Sheikhi, P. McFlynn, et al., Children's Sport Participation and Physical Activity Study 2022 CSPPA 2022 REPORT 2 Children's Sport Participation and Physical Activity Study 2022 3 CSPPA 2022 REPORT, 2022.

[28] L.J. Lieberman, J.A. Haegele, L. Columna, P. Conroy, How students with visual impairments can learn components of the expanded core curriculum through physical education, J Vis Impair Blind [Internet] 108 (3) (2014 May 1) 239–248. Available from: https://journals.sagepub.com/doi/10.1177/0145482X1410800307.

[29] C.D. Lirgg, D.R. Gorman, M.D. Merrie, C. Shewmake, Exploring challenges in teaching physical education to students with disabilities, Palaestra 31 (2) (2017) [cited 2023 Oct 9], https://js.sagamorepub.com/index.php/palaestra/article/view/8428.

[30] K.P. Depauw, Physical education for the visually impaired: a review of the literature, J Vis Impair Blind [Internet] 75 (4) (1981 Apr 1) 162–164, https://doi.org/10.1177/0145482X8107500403.

[31] L.J. Lieberman, C. Houston-Wilson, F.M. Kozub, Perceived barriers to including students with visual impairments in general physical education, Adapt. Phys. Act. Q. (APAQ) 19 (3) (2002 Jul 1) 364–377 [cited 2023 Aug 24], https://journals-humankinetics-com.ucd.idm.oclc.org/view/journals/apaq/19/3/article-p364.xml.

[32] F.M. Kozub, H.K. Oh, An exploratory study of physical activity levels in children and adolescents with visual impairments, Clin. Kinesiol. 58 (3) (2004 Sep) 1–7.

[33] L.G. Sylvia, E.E. Bernstein, J.L. Hubbard, L. Keating, E.J. Anderson, A practical guide to measuring physical activity, J. Acad. Nutr. Diet. 114 (2) (2014 Feb) 199 [cited 2022 Nov 14] /pmc/articles/PMC3915355/.

[34] K. Ishikawa-Takata, I. Tabata, S. Sasaki, H.H. Rafamantanantsoa, H. Okazaki, H. Okubo, et al., Physical activity level in healthy free-living Japanese estimated by doubly labelled water method and International Physical Activity Questionnaire, Eur J Clin Nutr [Internet] 62 (7) (2008 Jul) 885–891. Available from: https://pubmed.ncbi.nlm.nih.gov/17522602/.

[35] Vision Sports Ireland, About us - vision sports Ireland [cited 2022 Dec 14]. Available from: https://visionsports.ie/about/about-us/, 2022.

[36] Microsoft Support, Microsoft forms - microsoft support [cited 2023 Mar 16]. Available from: https://support.microsoft.com/en-gb/office/use-a-screen-reader-to-explore-and-navigate-microsoft-forms-2c153d68-aee9-4c47-9a3b-092f11610827#PickTab=macOS, 2023.

[37] M.M. Yore, S.A. Ham, B.E. Ainsworth, J. Kruger, J.P. Reis, H.W. Kohl, et al., Reliability and validity of the instrument used in BRFSS to assess physical activity, Med. Sci. Sports Exerc. 39 (8) (2007 Aug) 1267–1274.

[38] K. Milton, F.C. Bull, A. Bauman, Reliability and validity testing of a single-item physical activity measure, Br. J. Sports Med. 45 (3) (2011 Mar 1) 203–208.

[39] J.J. Prochaska, J.F. Sallis, B. Long, A physical activity screening measure for use with adolescents in primary care, Arch. Pediatr. Adolesc. Med. 155 (5) (2001 May 1) 554–559 [cited 2023 Sep. 14, https://jamanetwork.com/journals/jamapediatrics/fullarticle/190611.

[40] International Paralympic Committee, Paralympic Classification, 2019. Paris.

[41] Paralympics Ireland, Vision impairment - Paralympics [internet]. https://paralympics.ie/vision-impairment/, 2023.

[42] Department of Health, Get Ireland active! The national physical activity plan for Ireland [cited 2023 Aug 29]. Available from: https://www.hse.ie/eng/about/who/healthwellbeing/our-priority-programmes/heal/heal-docs/get-ireland-active-national-physical-activity-plan-for-ireland.pdf, 2016.

[43] C. Brand, E. Dons, E. Anaya-Boig, I. Avila-Palencia, A. Clark, A. de Nazelle, et al., The climate change mitigation effects of daily active travel in cities, Transp Res D Transp Environ 93 (2021 Apr 1) 102764.
[44] K. Pérez, M. Olabarria, D. Rojas-Rueda, E. Santamariña-Rubio, C. Borrell, M. Nieuwenhuijsen, The health and economic benefits of active transport policies in Barcelona, J. Transport Health 4 (2017 Mar 1) 316–324.
[45] M. Loeb, C. Cappa, R. Crialesi, E. de Palma, Measuring child functioning: the UNICEF/Washington group module, Salud Publica Mex. 59 (4) (2017) 485 [cited 2023 Sep 7] /pmc/articles/PMC7373168/.
[46] J.L. Nuzzo, Sex difference in participation in muscle-strengthening activities, J Lifestyle Med [Internet] 10 (2) (2020 Jul 7) 110. Available from: /pmc/articles/PMC7502892/.
[47] E.A. Holbrook, J.L. Caputo, T.L. Perry, D.K. Fuller, D.W. Morgans, Physical activity, body composition, and perceived quality of life of adults with visual impairments, J Vis Impair Blind [Internet] 103 (1) (2009) 17–29. Available from: https://www.researchgate.net/publication/231556847_Physical_Activity_Body_Composition_and_Perceived_Quality_of_Life_of_Adults_with_Visual_Impairments.
[48] J. Marmeleira, L. Laranjo, O. Marques, C. Pereira, Physical activity patterns in adults who are blind as assessed by accelerometry, Adapt. Phys. Act. Q. (APAQ) 31 (3) (2014 Jul 1) 283–296 [cited 2023 Sep 5], https://journals.humankinetics.com/view/journals/apaq/31/3/article-p283.xml.
[49] J. Yeung, S. Wearing, A.P. Hills, Child transport practices and perceived barriers in active commuting to school, Transport. Res. Part A Policy Pract 42 (6) (2008 Jul 1) 895–900.
[50] P. Cheung, School-based physical activity opportunities in PE lessons and after-school hours: Are they associated with children's daily physical activity? 25 (1) (2017 Apr 20) 65–75 [cited 2023 Aug 23], https://journals.sagepub.com/doi/full/10.1177/1356336X17705274.
[51] Directorate-General for Mobility and Transport (European Commission) EC, EU Law COMMUNICATION from the COMMISSION to the EUROPEAN PARLIAMENT, the COUNCIL, the EUROPEAN ECONOMIC and SOCIAL COMMITTEE and the COMMITTEE of the REGIONS the New EU Urban Mobility Framework, 2021 Dec.
[52] Active Travel England, Active Travel England Corporate Plan, 2022.
[53] Auxter David, Principles and Methods of Adapted Physical Education and Recreation, vol. 20, 2010.
[54] L.J. Lieberman, C. Houston-Wilson, F.M. Kozub, Perceived barriers to including students with visual impairments in general physical education, Adapt. Phys. Act. Q. (APAQ) 19 (3) (2002) 364–377.
[55] P. te Braak, T.P. van Tienoven, J. Minnen, I. Glorieux, Data quality and recall bias in time-diary research: the effects of prolonged recall periods in self-administered online time-use surveys, Socio. Methodol. 53 (1) (2023 Feb 1) 115–138 [cited 2023 Oct 9], https://journals.sagepub.com/doi/full/10.1177/00811750221126499?casa_token=mSTBtFL5ToMAAAAA%3AtqCPGhEvP5EC3W6fhY4mauwTVJfMA81fR0-wyVGT78lJ6RhX8WWIZwFzLH62rhOdEVFJPFOaTtyMoA.
[56] C.E. Tudor-Locke, A.M. Myers, Challenges and opportunities for measuring physical activity in sedentary adults, Sports Med. 31 (2) (2001 Nov 29) 91–100 [cited 2023 Mar 16], https://link.springer.com/article/10.2165/00007256-200131020-00002.