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Research Article

The Validity and Reliability of the Digital Gaming and Physical Activity Relationship Scales Amongst Finnish Adolescents

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Although physical activity (PA) is an established pastime, digital gaming (DG) has created a new social world for young people. Scales to measure digital gaming relationships (DGRs) and physical activity relationships (PARs) are in their infancy. Therefore, the aim of this study was to investigate the properties and differences of the DGR and PAR scales used by adolescents. A convenience sample of high school students was recruited for the study. Participants completed the same questionnaire twice, with a 3-week interval between administrations. After merging and matching the two sets of responses, data from 116 students were analysed using intraclass correlation coefficients to assess intrarater reliability and principal component analyses to evaluate convergent validity. *T*-tests were used to determine gender differences in the DGR dimensions and linear associations with gaming and PA behaviour. After determining reliable items, five dimensions were found (competitiveness, social aspects, self-development, mental health and functional features). Cronbach's alphas for each dimension ranged from 0.74 to 0.94. Scores from males in four of the five dimensions were statistically significantly higher than females, and there were linear associations with gaming behaviour in four dimensions. To conclude, the DGR and PAR scales seem to be suitable for use by adolescents in surveys.

Keywords: health; leisure activities; meaningfulness; sport; video games

1. Introduction

Adolescence is the transition from child to adulthood. The age range can vary between 10 and 25 years [1], and adolescents undergo many bodily and psychological changes [2]. Changes may involve a significant decline in physical activity (PA) [3] despite the well-established long-term health benefits from being physically active [4] and evidence that participation in PA during adolescence increases the likelihood of continued participation in adulthood [5]. There are concerns that the increased popularity of digital gaming in recent years, particularly during the COVID-19 restrictions [6], plays a role in the decline in PA levels [7]. Insights into the social and cultural perceptions surrounding both gaming and PA behaviours may be instrumental in shaping health promotion strategies that encourage more participation in PA, prevention of dropout and increased awareness of the culture of gaming amongst adolescents.

Digital gaming is a contemporary behaviour that has grown in popularity in recent years. Several nuanced concepts around the culture of digital gaming that have emerged, such as virtual team building [8], performing in front of a virtual audience [9, 10], and being part of surreal stories or adventures while gaming [11], to name a few.

Although digital games may contribute to addiction and related disorders, particularly amongst adolescents [12], they still hold personal significance for many individuals. For example, it has been reported that adolescents improve their emotional regulation [13] or have been found to mitigate social anxieties, encourage relaxation and learning [14].

There is emerging literature that suggests the meaningfulness of gaming is also a significant social aspect of an individual's world [15]. For example, individuals who participate in multiplayer online games experience a sense of social capital, reducing the sense of loneliness and thus increasing levels of well-being [16]. Despite such findings, measures to investigate the meaningfulness of gaming are lacking.

Daneels et al. [17] suggested that the meaningfulness of digital gaming reflects a eudaimonic response similar to enjoyment, integrating elements of meaningfulness, appreciation and self-transcendence. Yet, meaningfulness on its own warrants greater attention. As such, there is a need for researchers, practitions, educators, and parents to engage in systematic inquiry to better understand how adolescents construct, experience, and value gaming within their social worlds. Digital gaming, as well as sport activity and PA, could be understood as culturally formed social worlds (see, e.g. Unruh) [18]. In that perspective, both social worlds are combinations of several meanings, where meanings refer to, for example, single features of gaming, and those features are noticed and valued in many different ways by young people. The total meaning, thus meaningfulness, of gaming or PA is seen as a sort of combination of several particles [19].

It has been hypothesised that meaningfulness in a behaviour is a key component in motivation [18]. Unlike short-term motivational attributes, meaningfulness exemplifies the long-term factors of commitment, whereby more and stronger meanings adapted with behaviours can lead to deeper engagement in the social world in question [19]. As such, a multidimensional approach to meanings is needed to help identify individuals' motivation towards gaming. Yet, an instrument in the areas to measure digital gaming relationships (DGRs) is lacking. There are commonalities between PA and digital gaming, as characterised by esports [20]. Meaningfulness in PA has been measured by the concept of physical activity relationships (PAR) [21]. A scale has been used to define the dimensions that are important to individuals' relationships with PA. The meanings of PA have been measured applying the PAR approach [21] which was based on eight meaning dimensions of PA: (1) competition and accomplishment, (2) health and healthiness aspects, (3) social aspects, (4) expressive aspects, (5) play and joy, (6) aspects of self, (7) growth and development and (8) discipline meanings [19].

Due to the expected similarities between gaming and PA, the aim of this study was to develop an instrument, based on the PAR, that would reflect DGR, and to test its reliability and validity. Furthermore, as there are large behavioural differences by gender in both behaviours, this study aimed at seeking differences in DGR by adolescent males and females.

2. Methods

2.1. Participants. Participants were recruited through a convenience sample that included a high school in the southwest Finland region. Only participants over the age of 16 years were informed about the study, who then gave their consent to take part in the study involving survey completion during school hours. In line with the University of Turku research ethical review board, based on the Helsinki Declaration on research ethics, this type of survey based research did not require approval from an ethics committee.

Arrangements with the local education authority and the school principal were made to permit data collection during school hours. It was suggested by the school to carry out the online survey during the registration time at the beginning of the school day. This was to facilitate as many students as possible in the high school to complete the survey. To reach a balance between recall of response and reduced risk of change in behaviours, a test–retest period of 3 weeks was chosen, as recommended in earlier studies [22]. The retest took place under the same circumstances as conducted earlier for the test survey. Each student was provided a participant ID number of nonidentifiable nature, which was used to link responses across both surveys.

2.2. Instruments

2.2.1. Background Questions. Background questions included gender, age and academic grade, as determined by students' recall of their recent Finnish language grade. Upon initial analyses, there were too few numbers of responses of 'other gender' ($n = 5$) to be included in the analyses. The academic grade is outlined by the teacher for the student's Finnish subject grade and is known by students with a score from 4 to 10, with 10 being the highest score. Three questions were combined based on the time spent on playing digital games on computers, consoles and mobile phones. Another question on the number of days of at least 60 min of moderate-to-vigorous physical activity (MVPA) was asked. The gaming items were combined and grouped into less than weekly, weekly and daily. MVPA was categorised into four groups (0–2, 3–4, 5–6 and 7 days), as performed in earlier studies [23]. These questions were used to describe the participants in this study.

2.2.2. Digital Gaming and PAR Scales. Items to measure DGR were carried out through qualitative work and review of the literature. There were eight identified domains in the DGR. Similar to the PAR meaning measure [21], participants were asked, "Reflect on your relationship with digital games and playing them. Which of the following things are important or less important to you in your own gaming?" The response scale went from *not at all important* (0), *low importance* (1), *slightly important* (2), *moderately important* (3), *important* (4) and *very important* (5). Updates from the PAR questionnaire were integrated to suit the digital gaming context. Specifically, additional items were included where they were deemed to be missing [24]. Items were tested for robustness in English and Finnish language, as well as treatment as single concept items. For example, one item from

the PAR scale was in the competition dimension, namely, 'success and winning'. As 'success' and 'winning' may be two different concepts, the item was reviewed as two separate items. Further conceptual discussions led to conclusions to keep the two as one item. After several rounds of tweaking for linguistics and conceptual discussions, five dimensions (joy, self-development, fantasy, health and social aspects) had six items, and two dimensions (competitiveness and functional features) had seven items. This left a total number of 44 items in the pilot DGR scale. The same items were then repeated for PA, although the heading of the question was modified for the PA context. Totally, there were 88 items across the two contexts.

2.3. Analysis. Descriptive statistics were carried out to identify potential personal characteristics differences amongst the respondents. Independent *T*-tests were carried out on academic scores. Time spent playing digital games on a computer, consoles and mobile phones, as well as MVPA between males and females, were analysed by chi-square test of independence.

To assess the reliability and validity of the items in DGR and PAR, the stability was assessed through intrarater reliability statistics through the intraclass correlation coefficient (ICC) for each item. Interpretation of the ICC was; less than 0.5 = *poor*, between 0.5 and 0.0749 = *moderate*, 0.75–0.899 = *good* and above 0.9 = *excellent*, as recommended by Koo and Li [25]. Items from either DGR or PAR with ICC less than 0.5 were removed from further analyses.

Principal component analyses were used to identify the convergent validity of the DGR. An exploration approach was used through IBM SPSS v27, with oblimin rotation to produce the optimal number of factors. To ensure parsimony between PAR and DGR, the items had to have agreement in the same factor for both scales. Once the items were assigned to factors, three items with the highest scores were used to form a dimension. The Cronbach alpha of these items for each dimension was then measured for DGR and PAR independently.

Mean scores of the items from both time points in each dimension were calculated. Missing values were treated as random. Differences in mean scores between males and females were conducted by using independent *T*-tests, and effect sizes were measured by Hedge's *g*. Interpretation of effect size smaller than 0.4 = *poor*, between 0.4 and 0.7 = *moderate* and above 0.7 = *good* [26]. Differences in dimensions by gaming behaviour and MVPA were conducted by one way analysis of variance.

3. Results

There were 176 students who completed the survey at the test phase, 161 students who completed the retest survey and 116 students who completed both that could be matched. After checking data for both DGR and PAR, the number of matched responses had reduced ($n = 92$).

There were more females (60%) than males (37%), and the average age of the participants was 17.4 years (SD = 0.69). Females had on average higher academic grades than males ($p < 0.001$). There were more males who reported to participate in gaming ($p < 0.001$) or PA ($p = 0.032$) daily than females (Table 1). Within differences in reports of gaming ($p = 0.35$) or PA ($p = 0.89$) behaviour were not statistically significant between both time points.

Scores from the final included DGR items were, on average, lower (T0 mean = 1.48, SD = 1.24; T1 mean = 1.34, SD = 1.23) than PAR items (T0 mean = 2.54, SD = 1.13; T1 mean = 2.43, SD = 1.15). The lowest mean value for DGR was for item functionalfeatures3 (toughness; T0 mean = 0.65, T1 mean = 0.84), and the highest DGR score was for item joy1 (playfulness of gaming; T0 mean = 2.6, T1 mean = 2.59). The lowest mean value for PAR was functionalfeatures7 (financial affordability; T0 mean = 1.49, T1 mean = 1.57), and the highest PAR item was health2 (promoting own well-being; T0 mean = 3.91, T1 mean = 3.68).

Of the 88 items, eight items (fantasy2, fantasy6, functionalfeasures2, heath1, joy1, joy2, joy3 and joy6) had ICC scores less than 0.5 and were subsequently removed from further analyses, leaving 36 items to be included in the validation testing. All other items had ICC range between 0.530 and 0.819 (Table S1). Following the examination of the items belonging to the factors, three items from five factors were chosen for the final instrument. Factor loadings and Cronbach alpha for both DGR and PAR are presented in Table 2. Original and translated into English versions are in Table S2.

3.1. Differences in Factors by Gender. In all DGR dimensions, males scored higher ratings of importance than females. Differences in DGR dimensions were statistically significant for the mental health ($p = 0.015$, $g = 0.38$), social aspects ($p < 0.001$, $g = 0.83$) and self-development ($p < 0.001$, $g = 0.75$) dimensions (Figure 1) with medium to large effects. Similarly, daily gamers scored significantly higher in all dimensions than less frequent players ($p < 0.001$). The differences in PAR scores between males and females were not statistically significant (Figure 2).

There were linear associations in all DGR dimensions, except for the competitive one, with increasing frequency of game play (Figure 3). The opposite was true for PAR, particularly in the mental health ($p = 0.002$, eta2 = 0.069) dimensions, as scores of each PAR dimension were lower as frequency of gaming increased.

Based on the different categories of PA frequency, there was a statistically significant linear increase in the competitiveness dimension from DGR ($p = 0.009$) and PAR ($p = 0.009$). There were also statistically significant differences in the mean scores of the DGR self-development dimension as PA frequencies changed (Figure 4).

4. Discussion

Following the test–retest and validity testing, the DGR and PAR instruments were reduced to 15 items each, with five dimensions. DGR and PAR could be used as a way to detect individual's relationship with the multidimensional concepts of digital gaming and PA, respectively. The reliability and validity properties of these scales were suitable for survey use and were tested amongst high school students. Furthermore,

TABLE 1: Sample descriptives by gender at baseline.

		Male ($n = 33$)	Female ($n = 59$)	p value
Age, mean (SD)		17.4 (0.78)	17.4 (0.63)	0.573
Academic grade		7.36	8.31	< 0.001
Gamers	Less than weekly	9.1	51.3	< 0.001
	Weekly	65.2	40.2	
	Daily	25.8	8.5	
MVPA	0–2 days	9.2	12.7	< 0.001
	3–4 days	20.0	37.3	
	5–6 days	32.3	33.9	
	7 days	38.5	16.1	

Abbreviation: MVPA, moderate-to-vigorous physical activity.

TABLE 2: Scale loadings for each dimension for DGR and PAR with Cronbach's alphas.

Scales	Items	Digital gaming relationship					Physical activity relationship				
		1	2	3	4	5	1	2	3	4	5
Competitiveness	Com1	0.867					0.895				
	Com2	0.872					0.913				
	Com6	0.755					0.515				
Social aspects	Soa1		0.839					0.771			
	Soa2		0.874					0.889			
	Soa4		0.867					0.865			
Self-development	Sel2			0.834					0.901		
	Sel3			0.802					0.902		
	Sel5			0.865					0.659		
Mental health	Hea3				0.931					0.884	
	Hea4				0.939					0.916	
	Hea5				0.905					0.912	
Functional features	Fuf4					0.669					0.734
	Fuf5					0.662					0.798
	Fuf7					0.805					0.629
	T0 alpha	0.825	0.875	0.913	0.937	0.783	0.825	0.878	0.850	0.915	0.783
	T1 alpha	0.848	0.924	0.931	0.943	0.735	0.848	0.889	0.841	0.936	0.735

scores of the scales were higher amongst males than females in four of the five dimensions in both DGR and PAR.

4.1. Scale Development. Differences amongst individuals may lead to several different meanings to PA and DG. From the examination of the literature concerning DGR, a list of potential 44 meanings were included in the scale and after reliability and validity testing, and the scales were reduced to five dimensions, each with three items. These dimensions were applicable to both DGR and PAR, which would give evidence that, despite PA and DG being different behaviours, the meaning associated with them can be categorised in similar ways. This can be useful to examine how individuals share similar or differing meanings between these two behaviours. By applying the two scales together in studies, it may improve insights into contemporary research based on multiple behaviours, such as the displacement theory, where individuals swap one behaviour for another [27]. Another perspective is that the day consists of 24 h, of which, even if individuals meet the current PA recommendations for children and adolescents [4], such behaviour accounts for less than 5% of the entire day. In other words, individuals may be active enough to meet the PA guidelines but may also spend several hours playing games nonstop. As such, it would be purposeful to have the same measures on individuals that can be compared between behaviours. Such ideas are not new. For example, this was also highlighted in self-efficacy theory, where there should be construct specificity when developing scales [28, 29].

After examining the literature and the possible areas of DGR and PAR, we started off with seven dimensions and between five and six items per dimension. As there are many idiosyncrasies with the construct of meanings [21], it was

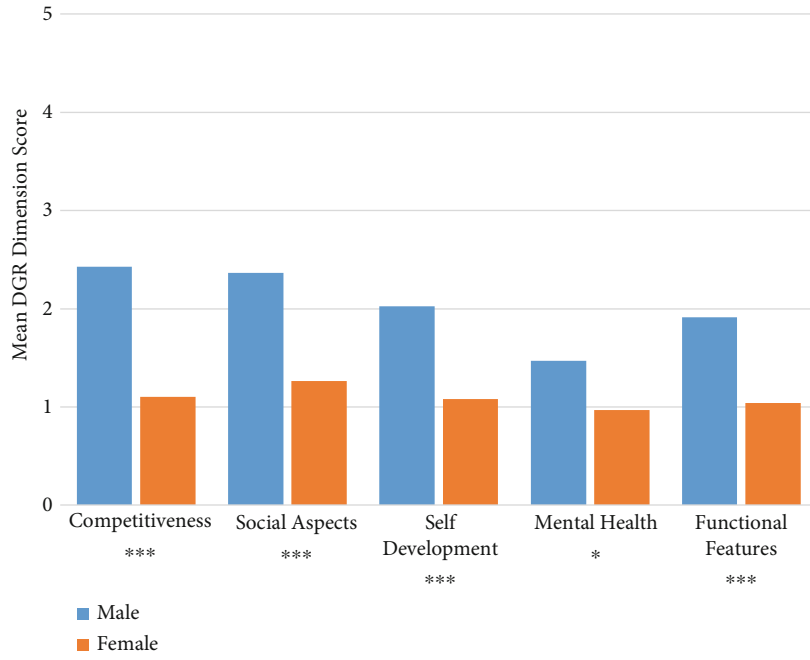

Figure 1: Mean scores (range 0–5) of digital gaming relationship dimensions by gender. $^{***}p < 0.001$, $^{**}p < 0.01$ and $^{*}p < 0.05$.

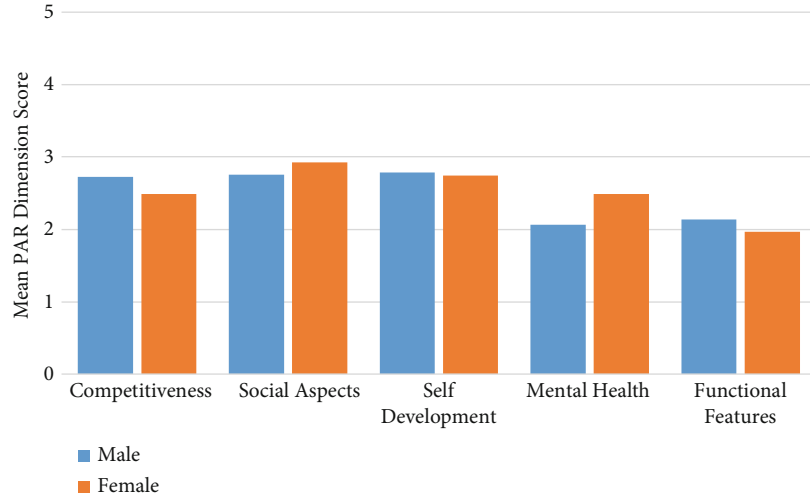

Figure 2: Mean scores (range 0–5) of physical activity relationship dimensions by gender.

important to approach the challenge of testing reliability of the items. Despite several rounds of refinement of items, such as keeping constructs as singular as possible and taking into account the cognitive processes for responding to surveys [30], not all items had adequate intrarater reliability scores. The items with the least reliability were in the joy and fantasy dimensions and were mainly reported in the PAR scale, whereas one item on the health dimension had low reliability in the DGR scale. It was expected that the health item is less relatable to DGR than PAR because gaming is often not positively associated with physical health parameters [31]. Additionally, individuals' relationship and meaning of physical health and gaming on the separate occasions for completing the survey would result in low intrarater reliability scores. For decades, playing computer games was considered to belong to the group of sedentary behaviours [32], with current WHO guidelines for sedentary behaviour to be limited [33], yet for gamers, few take part in PA, possibly due to the lack of evidence that being physically active can improve their game play [34].

The other seven items with low reliability scores were in the PAR scale in the joy, fantasy and functional features dimensions. The majority of items in the joy and fantasy dimensions were derived from the gaming literature [19, 35, 36]. As a result, it was not surprising that the items may have been less stable in relation to PA. As the aim of the scale was to create a ubiquitous scale of meanings across both gaming and PA behaviours, those items were dropped,

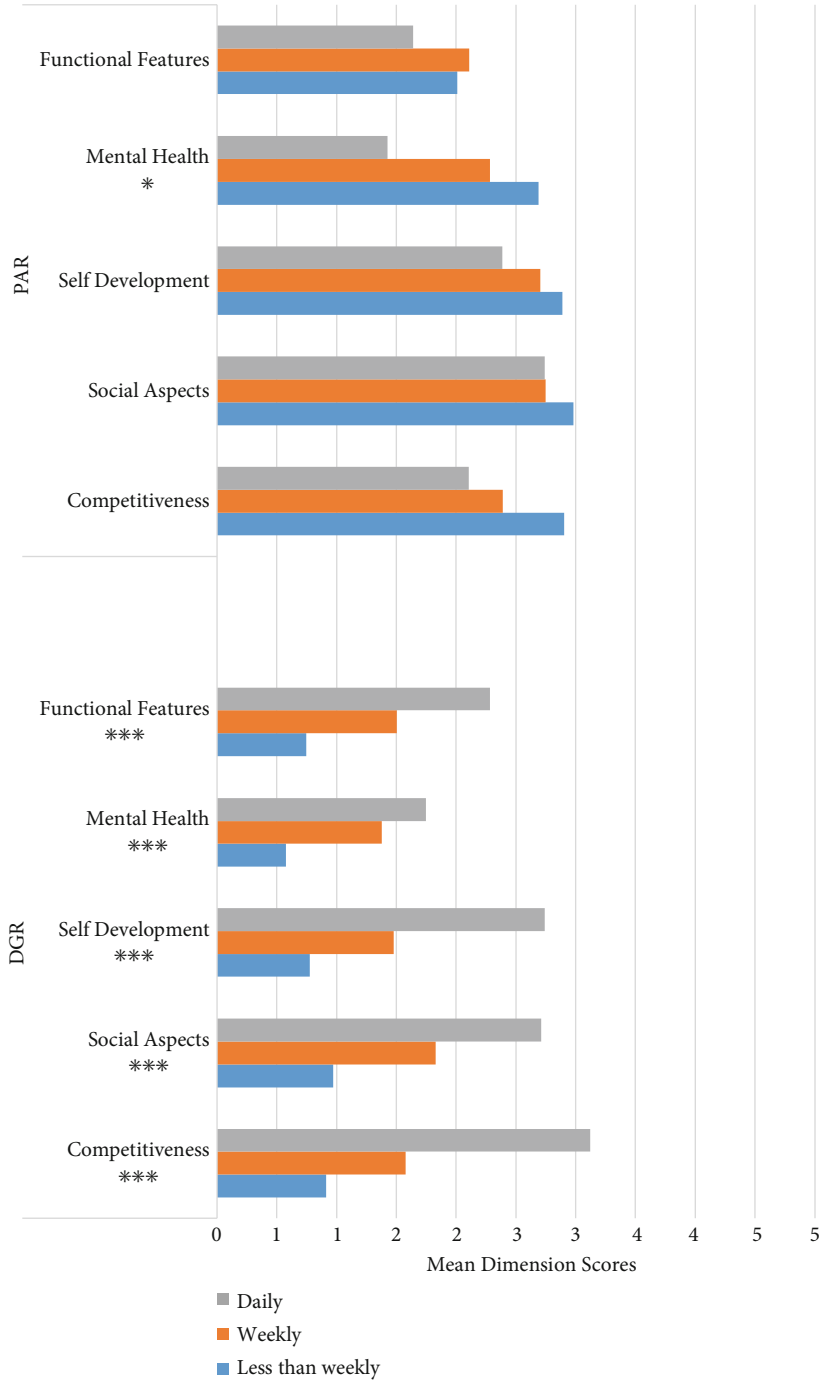

FIGURE 3: Differences in DGR and PAR scores (range 0–5) by gaming frequency. Note: $^{*}p < 0.05$, $^{**}p < 0.01$ and $^{***}p < 0.001$.

despite the strong links to the literature for one but not both behaviours. This was a similar reason for removing the physical health items when deciding on the final dimensions.

One aspect that these scales do not cover is the dimension of joy. This was due to the low reliability values in PAR. This was deemed as important to include because digital games are largely designed for entertainment purposes, which can be assumed to be associated with enjoyment and positive experiences. For example, Tuuri and Vahlo [37] reported all the gamers in their study were more motivated by fun than by other need-based gaming motives but also noted that the concept seems to be associated with everything. The concepts of fun or joy are highly subjective, and it is typical that games and gaming provide enjoyment for different individuals in different ways. More specifically, immersion and appearance can make games highly enjoyable [38]. The items used for this version of the scale were based on previous gaming literature such as the sense of competence in gaming [39] and using gaming to counterbalance the demands of everyday life [40]. Thus, it can be

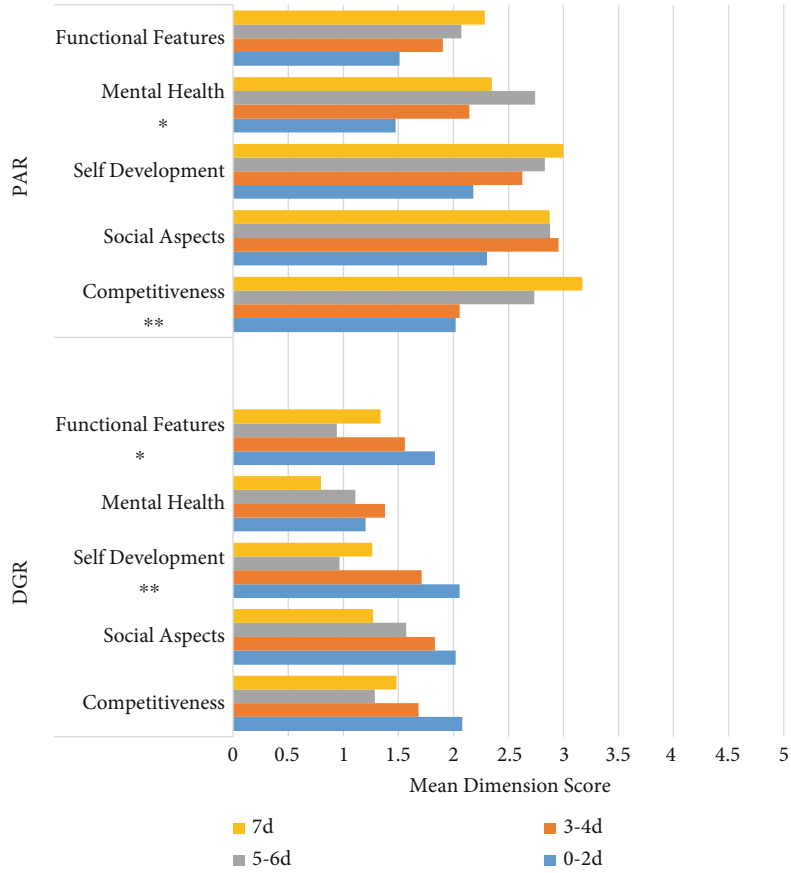

FIGURE 4: DGR and PAR scores (range 0–5) by MVPA frequency. Note: $^{*}p < 0.05$, $^{**}p < 0.01$ and $^{***}p < 0.001$.

argued that joy is an integral part of games and gaming but potentially did not tap directly into the PAR.

4.2. Associations Between Relationships and Behaviour by Gender. It has been reported that individuals who spend a lot of time playing digital games may find a lack of time to carry out other leisure time activities, such as regular PA [6, 41]. Although there are high levels of dropout in sport at high school students [3, 42], adolescence is a time of self-exploring and opportunities to try out thrill-seeking and risk-taking activities [2]. Participation in gaming may be perceived as a safe place for personal development, as it is carried out online, with the potential to improve well-being and avoidance of loneliness [16]. For recreational gamers where reported benefits included individuals' cognitive abilities (i.e., problem solving and spatial thinking), emotional control (i.e., adaptive regulation and happiness), social interaction (i.e., civic behaviour and social competences), as well as visual abilities (i.e., spatial resolution and selective visual attention) [43]. The motives behind taking up gaming are complex and multidimensional, as demonstrated through the self-determination theory [44].

Given the aforementioned different outcomes on the two behaviours, having a measure on the perceived importance of digital gaming an individual has can be useful for determining habits in digital gaming. With these distinctions, further research is needed to see how these dimensions may work in relation to other digital gaming measures, such as the behavioural ones that measure amount, intensity and type of gaming an individual does, as well as psychological profiles, motives and traits, alongside connections with bio-psychosocial indicators. Other lines of research may also explore the link between the meaningfulness of digital games with areas surrounding problematic gaming [45].

The evidence we provided on the scale was that males tended to score higher in each DGR dimension than females but not in PAR. There were also linear associations in all five DGR dimensions with increased gaming frequency and negatively with mental health and functional feature dimensions with increased PA frequency. These results support the current research on a male dominant gaming culture [46, 47] and that all dimensions appear to work well for DGR as predictors for gaming behaviour. Whereas with PA, it is well established that males participate in more PA than females [48], although some researchers have found that amongst Finland's high school students, gender differences were not that different after removing the proportion of students who reported daily PA [49]. More research is needed to understand the gender differences in the meanings of digital gaming and examine potential interventions that promote PA amongst females that can be transferred to the digital gaming environment.

5. Limitations

This is the first study, known to the authors, to have explored the reliability and validity of DGR and PAR scales. There are some study limitations that readers should take into consideration when interpreting the results. The sample was taken from a convenience sample based on one high school in Finland. This was not a representative sample, and results may differ across different ages, cultures and contexts, yet there were enough participants to make the statistical tests viable. Future studies examining the reliability and validity should consider more diverse samples. Another limitation is the time between surveys was 3 weeks. There may have been some individual variation in the perceived meanings over time, which could have different reliability scores to any scores generated if the time window was shorter. Although we found no meaningful difference in the behaviour, we do not have knowledge of what may have changed during the time, which led to changes in responses.

6. Conclusion

Despite PA and DG activities as two distinct behaviours common across adolescence, the interpretation of their meanings to participate can be similar for individuals. As such, this study sought to develop survey instruments to quantify common meanings for PA and DG. As a result of this study, five dimensions were proved to be reliable and valid for both behaviours that can be used to understand how adolescents have relationships with PA and DG. Such an instrument can be used to gain further insights into these common leisure time activities of adolescents.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

Author Contributions

K.N.: conceptualisation, methodology, formal analysis, writing—original draft and review and editing. M.S.: conceptualisation, writing—original draft and review and editing. P.H.: writing—review and editing. S.K.: writing—review and editing. P.K.: conceptualisation, writing—original draft and review and editing.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. *(Supporting Information Table S1: Scores (1–5n=128n=99)*

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