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Problematic mobile phone use among youth athletes: A topic modelling approach

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Abstract

The study provided an exploratory investigation into problematic mobile phone use among youth athletes. The study aimed to identify the factors contributing to problematic use and effects of problematic use among youth athletes. 369 Singaporean youth athletes, aged between 12 to 19 years old, participated in the study. A structural topic modelling approach using the R package *stm* was used to analyse the data. The process generated a list of topics for each of the open-ended survey questions. Subsequent interpretation was done to label the topics and group them into higher thematic categories. The prevalence of problematic mobile phone use in the sampled population was 40.65%. The analysis produced 38 topics for factors and 36 topics for effects. For factors, the higher thematic categories were habitual/compulsive use, accessibility/utility, alleviation of boredom/moods, lack of control, coping with school/work, entertainment, and communication. For effects, the higher thematic categories were time wastage/insufficient time, distraction/loss of focus, sleep/tiredness, sport-related areas, and addiction. The study provided novel insight into issues surrounding problematic mobile phone use among youth athletes. Future research needs to be conducted to further investigate the topics and themes that emerged.

Keywords: mobile phone, problematic use, youth, athlete, Singapore

Problematic mobile phone use among youth athletes: A topic modelling approach

Mobile phone use is a ubiquitous and essential part of modern society, with latest reports in April 2021 indicating that there are 5.27 billion unique mobile phone users in the world today (Digital Around the World, 2021). In the current smartphone era, the mobile phone has evolved into an integrated platform where the user can engage in various tasks and activities, such as social communication, entertainment, information seeking, and productivity (Ting & Chen, 2020). The popularity of mobile phones stems from its portability and multifunctionality, which results in individuals becoming more attached to and reliant on their mobile phones as compared to any other technological device (Ahn & Jung, 2016).

Understandably, with increased mobile phone use comes its accompanying problems and challenges as a significant number of people engage in excessive and problematic use (Yu & Sussman, 2020). The World Health Organization (WHO) has previously stated the potential health implications of excessive mobile phone use and suggested that it might present itself as a novel form of behavioural addiction (World Health Organization, 2015). The issue of problematic mobile phone use has been deemed a worldwide phenomenon, with various studies citing high prevalence rates in countries around the globe (Montag & Becker, 2020; Sohn, Rees, Wildridge, Kalk, & Carter, 2019; Yu & Sussman, 2020). For example, previous studies have shown a prevalence rate of 26% in Italian youths aged 10-16 years old (Cerutti, Presaghi, Spensieri, Valastro, Guidetti, 2016); 15.5% in Indian youths aged 13-17 years old (Rajanna, Sharma, & Palanichamy, 2016); and 27.5% in Chinese youths aged 12-17 years old (Li & Lu, 2017).

More specifically, problematic mobile phone use has been defined as a “maladaptive dependency or obsessive compulsive use of mobile phone, a state of being immersed in uncontrollable mobile phone usage, and the inability to control mobile phone use to the point

of experiencing adverse consequences in one's daily life" (Yu & Sussman, 2020, p. 12). Examples of problematic use include the use of mobile phones in prohibited or dangerous situations such as while driving, crossing the road, or during class time. While not yet formally recognised as a behavioural addiction by the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-V), several researchers have sought to incorporate criteria from existing disorders such as pathological gambling and substance abuse to help conceptualise problematic mobile phone use (e.g., De-Sola Gutiérrez, Rodríguez de Fonseca, & Rubio, 2016; Kwon, Kim, Cho, & Yang, 2013). This includes criteria such as loss of control, neglect of other activities, tolerance, withdrawal, preoccupation, and continued use despite harm (Kwon et al., 2013). These criteria are also very similar to problematic Internet use and problematic social media use, both of which have been shown to be highly correlated with problematic mobile phone use (Ayar et al., 2017; Tunc-Aksan & Akbay, 2019). While the above-mentioned criteria based on the addiction framework will form a key component of conceptualising problematic mobile phone use in this study, the current study will not utilise the term "mobile phone addiction" to describe the phenomenon at hand. This is based on recommendations from various authors (e.g., Panova & Carbonell, 2018; Ryding & Kuss, 2020), who recommended that the term "addiction" not be used, due to the current lack of clarity as to whether problematic mobile phone use can fully constitute an addictive behaviour. Instead, Ryding and Kuss (2020) advised researchers to use non-pathological terminology, such as "problematic mobile phone use", which we will be using for the purposes of this study.

There are several demographic factors, such as gender, that have been investigated in past literature in terms of their relationship with problematic mobile phone use. There is currently no firm consensus as to whether males or females are more susceptible to problematic mobile phone use (Busch & McCarthy, 2020). However, there is agreement that

males and females use their mobile phones for different purposes, with males preferring activities such as gaming and entertainment; while females use their mobile phones more for social interaction purposes (Busch & McCarthy, 2020; De-Sola Gutiérrez et al., 2016). In addition, problematic mobile phone use has shown to have negative effects on areas such as mental health (Elhai, Dvorak, Levine, & Hall, 2017), sleep (Hale & Guan, 2015), social relationships (Dwyer, Kushlev, & Dunn, 2018), work productivity (Duke & Montag, 2017), and academic performance (Felisoni & Godoi, 2018).

In recent years, researchers have begun to investigate the potential impact that mobile phone use can have on athlete performance and wellbeing in the college/adult population. One such study conducted with a varsity athlete sample has indicated certain specific issues associated with problematic mobile phone use (DesClouds & Durand-Bush, 2020). The negative effects uncovered in the study include: (1) stress – where athletes feel the pressure to reply messages, or fear missing out important events that might be happening online; (2) distraction – where athletes repeatedly check their phones during breaks in training, or are disrupted from their optimal sleep routine; and (3) disengagement – where athletes are so preoccupied with their mobile phone use that they are not fully invested in the task at hand, or have poorer social cohesion with their teammates (DesClouds & Durand-Bush, 2020). Another group of researchers (Fortes, Lima-Júnior, Gantois, Nasicmento-Júnior, & Fonseca, 2021; Fortes, Lima-Junior, Nascimento-Júnior, Costa, Matta, & Ferreira, 2019; Greco, Tambolini, Ambruosi, & Fischetti, 2017) have also discovered that mobile phone use before a sporting task has negative effects on subsequent sporting performance. Specifically, mobile phone use of 30 minutes or longer (for uses such as social media) just before a match/race was found to be detrimental to soccer players in terms of passing decision making and mental fatigue levels (Fortes et al., 2019), as well as ball control and running distance (Greco et al.,

2017); and to swimmers in terms of their 100m and 200m freestyle race performance and mental fatigue levels (Fortes et al., 2021).

In terms of the effect of mobile phone use on athletes' sleep, Jones et al. (2019) found that water polo athletes who had their mobile phones with them went to bed at later timings and spent less time in bed compared to those who did not have their mobile phones with them. Similarly, Romyn, Robey, Dimmock, Halson, and Peeling (2016) also found that higher durations of electronic device use (e.g., mobile phone use) before bedtime had a negative effect on sleep efficiency in netball athletes. Lastly, there have also been previous studies which found that engaging in mobile phone use (e.g., talking or texting) while exercising was associated with decreased intensity during exercise (Rebold, Lepp, Sanders, & Barkley, 2015; Rebold, Sheehan, Dirlam, Maldonado, & O'Donnell, 2016). Individuals who engaged in mobile phone texting during their workout were more likely to exercise at lower intensities (Rebold et al., 2016), and individuals who used their mobile phone (talking and texting) simultaneously during exercise chose to exercise at lower treadmill speed and had lower heart rate during their workout (Rebold et al., 2015).

Current literature suggests that the youth population is most susceptible to problematic mobile phone use (e.g., De-Sola Gutiérrez et al., 2016; George & Odgers, 2015). For example, a study by Choi, Kim, Eum, and Kim (2018) shows that the prevalence of problematic mobile phone use among youth and adolescents is 30.3%, while it is 15.9% among the overall population. Mobile phone use is highly prevalent among the youth population as they have been exposed to mobile phones at a young age and grow up using mobile phones as part of their everyday life (Ahn & Jung, 2016). George and Odgers (2015) suggest that mobile phones are increasingly being used by youths to facilitate key developmental tasks, such as communication with peers and establishment of friendship. Youth and adolescence are also a period of self-discovery and exploration, and mobile

phones provide the platform for youths to cultivate and form their identities in a virtual space (George & Odgers, 2015). Furthermore, the use of mobile phones affords youths a sense of independence and autonomy, where they can create their own online personas away from the scrutiny of parents and teachers (Ahn & Jung, 2016).

While literature is replete with evidence of how problematic mobile phone use can affect the general youth population (e.g., George & Odgers, 2015; Sohn et al., 2019), research on the youth athlete population is still in its infancy. In a recent article on coaching “Gen Z” athletes, Gould et al. (2020) highlight that mobile phone use among youth athletes is a significant problem in today’s sporting landscape. In their study, several coaches gave feedback that their youth athletes were constantly preoccupied with their mobile phones, which caused them to be more disengaged and disinterested in their sporting pursuits (Gould et al., 2020). Durand-Bush and DesClouds (2018) also highlight the prevalence and extent of mobile phone use among the current generation of athletes, and advocate that sport psychology practitioners be equipped with knowledge of how mobile phone use can impact sporting performance and wellbeing. They also note that there is a paucity of literature on the subject matter, and that more empirical research needs to be conducted to enhance current knowledge of mobile phone use among athletes (Durand-Bush & DesClouds, 2018).

While past research has suggested numerous ramifications of problematic mobile phone use, most of previous literature has been conducted in the college/adult athlete population and there is very limited research conducted in the youth athlete population. As mentioned previously (e.g., Ahn & Jung, 2016), youths are the demographic group which are most at-risk of problematic mobile phone use, and it is imperative to understand the issues surrounding their mobile phone use. This would help to inform future interventions that can be created to assist youth athletes in dealing with their problematic use. The previously mentioned study by Gould et al. (2020) only investigated the views of coaches and did not

consider the perspective of the youth athletes themselves. As such, there is a need to hear from the youth athletes, so as to fully comprehend their experience of problematic mobile phone use and how it might affect their lives.

In addition, we would like to examine the youth athlete population in the Singaporean context. Singapore is an extremely tech savvy nation which has a very high digital penetration rate, advanced mobile technology infrastructure, and high ownership of the latest smartphones ("Singapore Business Review," 2018). As such, mobile phone use among the general populace is accepted as commonplace and seen as an essential part of daily life. It is also of note that the current study took place during the COVID-19 pandemic period in Singapore, where students had to engage in "home-based learning", which necessitated the use of mobile technology. They were also unable to meet up with their friends due to limitations on group size and safe distancing regulations, which contributed to an increase in mobile phone use (Ong, 2021).

Therefore, the current study seeks to address the gaps in literature by exploring the various issues surrounding problematic mobile phone use among youth athletes in Singapore. In particular, the study seeks to address the following research questions: (1) What are the factors which contribute to problematic mobile phone use in youth athletes (*factors*)? (2) What are the effects of problematic mobile phone use in youth athletes (*effects*)? It is hoped that the findings of this study will prove useful to coaches, parents, and sport psychology practitioners, and help them to better understand their youth athletes who might be experiencing problematic mobile phone use.

Methods

Participants

A total of 369 Singaporean youth athletes (193 males, 176 females) participated in the study. The participants were all aged between 12 to 19 years old ($M = 14.94$, $SD = 1.71$), and were youth athletes who represented their schools at the national inter-school competition and trained at least once a week. Snowball sampling was utilised to recruit a large sample of youth athletes, and participants were recruited via email invitations to various schools, clubs, and youth sport organisations around Singapore. Relevant ethics board approval from the Nanyang Technological University Institutional Review Board (NTU IRB-2020-06-049) and parental consent was sought before participants could participate in the study. Data collection took place from September 2020 to March 2021. A wide variety of sports were represented: archery ($n = 2$), artistic swimming ($n = 4$), badminton ($n = 39$), basketball ($n = 7$), bowling ($n = 4$), canoeing ($n = 1$), cricket ($n = 2$), cycling ($n = 7$), equestrian ($n = 1$), fencing ($n = 13$), football ($n = 15$), golf ($n = 14$), netball ($n = 34$), rugby ($n = 63$), sailing ($n = 1$), shooting ($n = 33$), silat ($n = 13$), sport climbing ($n = 9$), swimming ($n = 36$), table tennis ($n = 4$), tennis ($n = 8$), touch rugby ($n = 8$), track and field ($n = 18$), ultimate frisbee ($n = 1$), water polo ($n = 19$), wushu ($n = 13$).

Survey

Participants were asked to complete an online survey on the Microsoft Forms platform. The survey form required participants to fill in demographic information such as their age, gender, and sport. This was followed by questions pertaining to their frequency of mobile phone use ("On an average, how often do you check your phone each day?"), as well as duration of mobile phone use ("On an average, how many hours do you spend on your mobile phone each day?"). Based on recommendations from Boase and Ling (2013), categorical measures of frequency and duration of mobile phone use were used instead of continuous measures. Past research has shown that duration and frequency of mobile phone use are linked to problematic mobile phone use; in particular, use of more than four to six

hours per day (Haug et al., 2015; Tamura, Nishida, Tsuji, & Sakakibara, 2017). The categorical options provided for frequency of mobile phone use were: 1 – “every 15 minutes or less”, 2 – “every 16-60 minutes”, 3 – “every 1-2 hours”, 4 – “every 2-4 hours”, 5 – “longer than every 4 hours”. The categorical options provided for duration of mobile phone use were: 1 – “less than 1 hour”, 2 – “1-2 hours”, 3 – “2-4 hours”, 4 – “4-6 hours”, 5 – “more than 6 hours”.

To address the two research questions, two open-ended questions were asked to participants. The first question was, “What factors might contribute to your problematic mobile phone use?” (*Factors*); and the second question was, “What are the effects of problematic mobile phone use on you as an athlete?” (*Effects*). Participants were told to respond as honestly and in as much detail as possible, and were also given the following definition of problematic mobile phone use (based on Yu & Sussman, 2020) to guide them in their responses: “The inability of a person to regulate or control his/her own mobile phone use. Results in negative consequences for daily life functioning.”

In addition, the Smartphone Addiction Scale – Short Version (SAS-SV; Kwon et al., 2013) was also included in the online survey form. The SAS-SV was selected as the assessment tool of choice as it was developed and validated for specific use among the adolescent and youth population. It assesses common areas associated with problematic mobile phone use, such as tolerance, withdrawal, preoccupation, neglect of other activities, loss of control, and continued use despite harm. It comprises of 10 items rated on a six-point Likert-type scale, ranging from “Strongly Disagree” (1) to “Strongly Agree” (6). Examples of questions include: “I am impatient and fretful when I am not holding my smartphone”, and “I will never give up using my smartphone even when my daily life is already greatly affected by it”. These items were determined by a seven-member expert panel of psychiatrists, medical professionals, and psychologists (Kwon et al., 2013), which contributed to its content

validity. Concurrent validity was achieved by comparing it to other measures of problematic mobile phone use, such as the Smartphone Addiction Proneness Scale (SAPS; Kim, Lee, Lee, Nam, & Chung, 2014). Based on previous research by Kwon et al., (2013), a cut-off value of 31 has been proposed for males and a cut-off value of 33 for females. This was determined using a random sample of 150 adolescents who were assessed by trained clinical psychologists. Receiver operating characteristics (ROC) analysis was used to examine the diagnostic ability of the SAS-SV and determine the cut-off points (Kwon et al., 2013). The SAS-SV has demonstrated strong internal consistency across numerous studies, with Cronbach's alpha coefficient ranging from .84 to .91 (e.g., Kwon et al., 2013; Samaha & Hawi, 2016; Wolniewicz, Tiamiyu, Weeks, & Elhai, 2018); and the Cronbach's alpha for the current study was .80.

Data Analysis

Due to the exploratory nature of the study and the purpose of investigating the youth athletes' open-ended responses, a structural topic modelling approach was used to analyse the text-based data. Topic modelling is a text-mining technique used to investigate the latent thematic structure of a given collection of open-ended responses. Topic modelling has gained momentum in the academic circles as a viable and innovative tool to analyse a large corpus of open-ended responses in a systematic way (Bai, Zhang, Li, Zhou, & Yuen, 2021). It aims to uncover the main topics and themes from a large collection of text, and does so swiftly and efficiently using a computerised method (Korfiatis, Stamolampros, Kourouthanassis, & Sagiadinos, 2019).

In the present study, the structural topic modelling analysis was conducted using the R package *stm* developed by Roberts, Stewart, and Tingley (2019), which was run with R version 3.6.3 in R Studio version 1.2.5042. The analytical approach used in the current study

was based on the guides by Roberts et al., (2014) and Roberts et al. (2019). (Please refer to Appendix A for a step-by-step guide on how the structural topic modelling analysis was conducted.)

Interpretation. Once the results were generated, two researchers embarked on the process of interpreting and labelling the topics. The first researcher did the initial interpretation and labelling, while the second researcher helped to verify and validate the labels that were given to each topic. In accordance with the guide by Roberts et al. (2019), the highest probability words as well as FREX weighted words (i.e., words that were weighted according to the overall exclusivity and frequency) were used as the main indices to determine what the label of each topic should be. For topics which did not have words that could be coherently interpreted, they were labelled as “unclear”. In addition, five quotations highly associated with each topic were generated using the *findThoughts* function, and were examined to ascertain whether the topic label accurately represented the actual participant responses. This was done to further ensure the accuracy and validity of the topic labels. Once the final topic labels were confirmed, they were further grouped into higher thematic categories.

Results

Descriptive Statistics

The SAS-SV scores ranged from 10-53 ($M = 29.81$, $SD = 8.66$). 150 out of the 369 participants (40.65%) met the cut-off score for problematic mobile phone use, based on the cut-off scores recommended by Kwon et al. (2013). Of the 150 who met the cut-off, 81 were male and 69 were female, and had a mean age of 14.92 years ($SD = 1.79$). Information pertaining to the frequency of mobile phone use can be found in Figure 1, and duration of mobile phone use can be found in Figure 2.

Preliminary Comparisons

A series of one-way analyses of variance (ANOVAs) were conducted to examine how the frequency and duration of mobile phone use was related to the SAS-SV scores. For frequency of mobile phone use, there was an overall significant effect [$F(4,364) = 7.20, p < .01$], and Tukey post-hoc tests showed that participants who used their phones every 15 minutes or less ($M = 32.73, SD = 8.85$) had significantly higher SAS-SV scores than those who used their mobile phones every 1-2 hours ($M = 28.35, SD = 7.83, p = .03$), every 2-4 hours ($M = 26.32, SD = 7.41, p < .01$), and longer than every 4 hours ($M = 25.11, SD = 7.89, p < .01$). Similarly, participants who used their phones every 16-60 minutes ($M = 31.29, SD = 8.82$) had significantly higher SAS-SV scores compared to those who used their mobile phones every 2-4 hours ($p < .01$), and longer than every 4 hours ($p = .02$).

For duration of mobile phone use, there was an overall significant effect [$F(4,364) = 7.21, p < .01$], and Tukey post-hoc tests showed that participants who used their phones for less than one hour per day ($M = 20.14, SD = 6.57$) had significantly lower SAS-SV scores than those who used their mobile phones for 2-4 hours ($M = 29.66, SD = 8.27, p = .03$), 4-6 hours ($M = 31.98, SD = 9.32, p < .01$), and more than 6 hours ($M = 32.56, SD = 7.90, p < .01$). Similarly, participants who used their phones for 1-2 hours per day ($M = 26.94, SD = 7.59$) had significantly lower SAS-SV scores compared to those who used their mobile phones 4-6 hours ($p < .01$), and more than 6 hours ($p = .01$).

Structural Topic Modelling

Selection of optimal k . Using the multi-step process highlighted in Appendix A, the optimal k values (i.e., optimal number of topics) were determined for each of the open-ended questions that were being analysed. For question 1 (factors), the optimal k was 38; for question 2 (effects), the optimal k was 36. Please refer to Appendix B for information

pertaining to the held-out likelihood, residuals, and semantic coherence values which were used to determine the optimal value of k for each question.

Topics and thematic categories. A summary of the thematic categories can be found in Table 1. The topics that were most prominent were as follows: For factors, Topic 5 (Phone always available for use), Topic 11 (De-stress from work), Topic 4 (Notifications); for effects, Topic 10 (Poor performance), Topic 30 (Time wastage), Topic 16 (Addiction). For the complete lists of topics (with their top words and topic proportions) and their corresponding thematic categories, please refer to Appendix C for factors, and Appendix D for effects.

Comparisons were made between problematic mobile phone users and non-problematic users (as assessed by the SAS-SV), but no significant differences were found between the groups in terms of topic prominence for any of the topics generated.

Discussion

The current study sought to provide an exploratory investigation into problematic mobile phone use among the youth athlete population. This was a novel and significant area of study, as there had been a lack of previous research conducted in the youth athlete population. The study generated a diverse range of topics related to the factors which contributed to problematic use and the effects of problematic use.

Prevalence and Preliminary Findings

The prevalence of problematic mobile phone use (as assessed by the SAS-SV) among the youth athletes sampled in this study was 40.65%. It must be noted that this figure was higher than most other studies in past research. For example, previous studies had shown a prevalence rate of 26% in Italian adolescents aged 10-16 years old (Cerutti et al., 2016); 15.5% in Indian adolescents aged 13-17 years old (Rajanna et al., 2016); and 27.5% in

Chinese adolescents aged 12-17 years old (Li & Lu, 2017). This suggested that problematic mobile phone use was a significant issue facing the youth athlete population in Singapore, and lent further credence to the need for better understanding of problematic use within this population.

Factors

In terms of factors which contributed to problematic mobile phone use among youth athletes, the topics and themes that emerged were mostly in agreement with previous literature conducted within the general youth population (e.g., Busch & McCarthy, 2020; Ting & Chen, 2020). In addition, there were three themes which corroborated with a previous study conducted with college athletes (DesClouds & Durand-Bush, 2020), namely “Alleviation of boredom/moods”, “Habitual/compulsive use”, and “Accessibility/utility”.

For the theme of “Alleviation of boredom/moods”, DesClouds and Durand-Bush (2020) made a similar claim that college athletes used their mobile phones to occupy time, deal with boredom, or procrastinate when doing uninteresting tasks. This was consistent with previous research which indicated that mobile phones were able to function as a coping mechanism to help individuals alleviate boredom and deal with negative emotions (Chen et al., 2017; Ting & Chen, 2020). Billieux, Maurage, Lopez-Fernandez, Kuss, and Griffiths (2015) suggested that individuals who possessed an acute sensitivity to stimulation and rewards used their mobile phones to alleviate boredom, as it was able to provide quick and instantaneous entertainment. For the theme of “Habitual/compulsive use”, the study by DesClouds and Durand-Bush (2020) gave a similar report that college athletes engaged in constant mobile phone checking behaviours at competition and practice. This was mainly attributed to the fear of missing out (FOMO; Przybylski, Murayama, DeHaan, & Gladwell, 2013), which was linked to two of the topics (Topics 26 “Missing important things” and 27

“Become habit/FOMO”) in this thematic category. Habitual use was often characterised by the lack of conscious thinking or self-instruction in mobile phone use, which could lead to problematic consequences for the individual (van Deursen, Bolle, Hegner, & Kommers, 2015). For the theme of “Accessibility/utility”, the constant availability of the mobile phone for use (Topic 5) and the ease of access (Topic 36) contributed to problematic use. This was in conjunction with the study by DesClouds and Durand-Bush (2020), which stated that the ubiquity of the mobile phone and its attractive features contributed to increased usage among college athletes. The authors cited the example of athletes using their mobile phones during waiting times and in transit due to it being the most salient and accessible object in their possession.

The theme of “Coping with school/work” was unique to the youth demographic sampled in this study, as the youth athletes utilised their mobile phones to cope with the stress and demands of school. Previous studies had outlined the effects of problematic mobile phone use on school/academic performance (e.g., Felisoni & Godoi, 2018), but there had been a lack of studies which sought to explore the role of school-related stress in perpetuating problematic use among the youth population. Past research had shown that students in Asian countries, in particular Singapore, experienced extremely high levels of stress due to the academic demands of the school system (Tan & Yates, 2011). There was reason to believe that student-athletes, who had to juggle their academic and sporting commitments, could possibly face an even greater amount of stress than regular students, and would therefore rely on their mobile phones as an outlet to cope with stress.

The final theme to be highlighted was “Lack of control”. This theme adhered to the pathway model of problematic mobile phone use conceptualised by Billieux et al. (2015), which proposed that individuals who engaged in problematic use had faulty self-control mechanisms and lacked the ability to properly regulate their mobile phone usage. In fact,

several authors (e.g., De-Sola Gutiérrez et al., 2016; Yu & Sussman, 2020) had previously suggested that the loss of control should be a key criterion in any formulation of problematic mobile phone use, due to its significance and role in problematic use.

Effects

In terms of the effects of problematic mobile phone use among youth athletes, the novel contribution of the current study stemmed from the sport-related topics which emerged from the topic modelling analysis. It was evident from the topics that were generated that problematic mobile phone use had an adverse effect on various areas of sporting performance such as concentration (Topic 31) and training quality (Topic 6). DesClouds and Durand-Bush (2020) suggested that the negative effect on sporting performance could have been due to the energy and attention that athletes devoted to their mobile phone use, which left reduced cognitive capacity for the sporting task at hand. This assertion was supported by several researchers (Fortes et al., 2019; Fortes et al., 2021) who found that athletes had increased mental fatigue levels after a prolonged period of mobile phone use (30 minutes or longer). The current study also indicated that problematic mobile phone use served to divert the athlete's time and energy away from beneficial sport-related activities such as exercising in free time (Topic 19) and recovery (Topic 7). It was evident that some youth athletes would rather use their mobile phones than engage in such activities that could benefit their sporting performance.

This was related to the next thematic category, which was "Sleep/tiredness". Past research had been divided with regards to the effect of mobile phone use on sleep in athletes, with some authors suggesting that it had a detrimental effect on areas such as sleep efficiency and bed timings (Jones et al., 2019; Romyn et al., 2016); while other authors suggested that there were no observable effects on athlete sleep (Dunican et al., 2017; Harris et al., 2015;

Jones et al., 2018). However, it must be noted that for the studies which did not observe any negative effects on sleep (e.g., Dunican et al., 2017; Jones et al., 2018), those studies were conducted in a training camp setting where the scheduling (including sleep-wake hours) was strictly dictated, which could have affected the results obtained. It is possible that athletes in a more naturalistic setting (i.e., their home environment) might have their sleep adversely affected by problematic mobile phone use, as there would be less control and regulation of their sleep schedule. This was supported by DesClouds and Durand-Bush (2020), who found that the college athletes were distracted from their ideal sleep routine by mobile phone use. It was stated in their study that certain athletes felt the least amount of control over their mobile phone use during bedtime; while others felt “trapped” by the constant influx of content and notifications on their phone, even though they were very tired and wanted to sleep.

The final thematic category to be highlighted was “Time wastage/insufficient time”. This was once again in line with previous research among college athletes, which showed that mobile phone use resulted in a lack of time to complete both academic and sporting tasks (DesClouds & Durand-Bush, 2020). As mentioned in the previous section, this was especially relevant for student-athletes (particularly in Asian countries; Tan & Yates, 2011) as they had to juggle both school and sporting commitments and were often hard pressed for time. Youth athletes who engaged in problematic mobile phone use would have even less time to devote to important tasks, which would diminish their abilities to perform both as a student and athlete.

Applied Implications

The findings of this study are useful to coaches, parents, and sport psychology practitioners who work with youth athletes, as they give insight into the issue of problematic mobile phone use among this population. It is evident that problematic mobile phone use is a

significant issue among youth athletes, given the high prevalence rate of 40.65% in this study. As such, more interventions and strategies need to be formulated to help youth athletes deal with their problematic use. There needs to be an awareness of the factors surrounding problematic use, where youth athletes may use their mobile phones to alleviate boredom or negative moods; might lack the control mechanisms to regulate their own mobile phone use; or might be drawn into a pattern of habitual and compulsive use. Potential intervention strategies to help such youth athletes can include the use of apps such as AppDetox (Lochtefeld, Bohmer, & Ganev, 2013) and NUGU (No Use is Good Use; Ko et al., 2015), or even the in-built iOS Screen Time or Android Digital Wellbeing apps, which have shown promise in past research in helping individuals to control their problematic mobile phone use. There can also be educational programmes created specifically for youth athletes, to help them to understand the effects of problematic use and cultivate positive mobile phone use habits. Such educational programmes have shown to be effective in past research among the general population (Choi, 2015; Gui, Fasoli, & Gerosa, 2019), and could potentially benefit the youth athlete population as well. In addition, efforts can be made to engage parents and coaches to be involved in the process of improving their youth athletes' mobile phone use behaviours. Previous research has demonstrated the importance of family digital literacy practices in helping youths to use their mobile phones in adaptive ways (Terras & Ramsay, 2016), and having the support of parents and coaches can empower youth athletes to overcome their struggles with problematic mobile phone use.

Limitations and Suggestions for Future Research

The current study only sampled Singaporean youth athletes, so the findings might not be generalisable to youth athletes from other countries. As previously mentioned, Singaporean youths operate in a very demanding education system where a lot of emphasis is placed on academic success (Tan & Yates, 2011). Therefore, the stress that Singaporean

youth athletes face in terms of juggling both sporting and academic pursuits might be different from youth athletes in other countries. In addition, Singapore has a very high digital penetration rate, with advanced mobile technology infrastructure and high ownership of the latest smartphones ("Singapore Business Review," 2018). As such, the findings might be different for youth athletes in countries which do not have such good mobile phone connectivity or access to the latest mobile phone devices. Future research needs to be conducted in other countries to identify the similarities or differences that might exist for their youth athletes.

The study occurred during the COVID-19 pandemic period, which could have influenced the results obtained (as opposed to non-pandemic times). In addition, the study utilised self-report measures of the frequency and duration of mobile phone use, which might have resulted in the participants under-reporting their actual use. The study also utilised a strict cut-off score based on the SAS-SV to assess the participants who had high or low levels of problematic mobile phone use. It is possible that certain participants who had scores bordering around the cut-off point might not have fit accurately into either high or low category.

Due to the novelty of the topic matter, the current study only aimed to provide an exploratory investigation into the issue of problematic mobile phone use among youth athletes. The topic modelling approach used in this study was limited in the sense that it only provided a broad overview of the key themes and topics that were related to problematic mobile phone use. As such, future research needs to be conducted to properly ascertain the underlying reasons and mechanisms behind the various factors and effects found in the study. This could come in the form of qualitative interviews or focus group sessions, to delve deeper into the themes and topics that emerged from this study. Future studies also need to be conducted to create and test the efficacy of interventions to help youth athletes deal with

problematic mobile phone use. As mentioned by Durand-Bush and DesClouds (2018), this is an increasingly significant but scarcely researched area of study, and more empirical research needs to be conducted to enhance current knowledge of the topic.

Conclusion

The current study provided an exploratory investigation into the issue of problematic mobile phone use among youth athletes. The high prevalence rate of 40.65% suggested that problematic mobile phone use was a significant issue faced by youth athletes. The factors which contributed to problematic use included habitual/compulsive use, accessibility/utility, alleviation of boredom/moods, lack of control, coping with school/work, entertainment, and communication. The effects of problematic use included time wastage/insufficient time, distraction/loss of focus, sleep/tiredness, sport-related areas, and addiction. Future research needs to be conducted to further investigate the underlying reasons and mechanisms behind the findings of this study.

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No potential competing interest was reported by the authors.

References

- Ahn, J., & Jung, Y. (2016). The common sense of dependence on smartphone: A comparison between digital natives and digital immigrants. *New Media & Society, 18*(7), 1236-1256. doi:10.1177/1461444814554902
- Ayar, D., Bektas, M., Bektas, I., Kudubes, A. A., Ok, Y. S., Altan, S. S., & Celik, I. (2017). The effect of adolescents' internet addiction on smartphone addiction. *Journal of Addictions Nursing, 28*(4), 210-214. doi:10.1097/JAN.0000000000000196
- Bai, X., Zhang, X., Li, K. X., Zhou, Y., & Yuen, K. F. (2021). Research topics and trends in the maritime transport: A structural topic model. *Transport Policy, 102*, 11-24. doi:10.1016/j.tranpol.2020.12.013
- Billieux, J., Maurage, P., Lopez-Fernandez, O., Kuss, D. J., & Griffiths, M. D. (2015). Can disordered mobile phone use be considered a behavioral addiction? An update on current evidence and a comprehensive model for future research. *Current Addiction Reports, 2*(2), 156-162. doi:10.1007/s40429-015-0054-y
- Boase, J., & Ling, R. (2013). Measuring mobile phone use: Self-report versus log data. *Journal of Computer-Mediated Communication, 18*(4), 508-519. doi:10.1111/jcc4.12021
- Busch, P. A., & McCarthy, S. (2020). Antecedents and consequences of problematic smartphone use: A systematic literature review of an emerging research area. *Computers in Human Behavior, 114*, 106414. doi:10.1016/j.chb.2020.106414
- Cerutti, R., Presaghi, F., Spensieri, V., Valastro, C., Guidetti, V. (2016). The potential impact of Internet and mobile use on headache and other somatic symptoms in adolescence: A population-based cross-sectional study. *Headache, 56*(7), 1161-1170. doi:10.1111/head.12840

- Chen, C., Zhang, K. Z., Gong, X., Zhao, S. J., Lee, M. K., & Liang, L. (2017). Examining the effects of motives and gender differences on smartphone addiction. *Computers in Human Behavior*, 75, 891-902. doi:10.1016/j.chb.2017.07.002
- Choi, N. (2015). The effects of a smartphone addiction education program for young adult females. *International Journal of U-and E-Service, Science and Technology*, 8(12), 277-284. doi:10.14257/ijunesst.2015.8.12.28
- Choi, D. J., Kim, Y. S., Eum, N. R., Kim, H. S. (2018) *The survey on smart phone overdependence*. Seoul: Ministry of Science and ICT & National Information Society Agency.
- De-Sola Gutiérrez, J., Rodríguez de Fonseca, F., & Rubio, G. (2016). Cell-phone addiction: A review. *Frontiers in Psychiatry*, 7, 175. doi:10.3389/fpsy.2016.00175
- DesClouds, P., & Durand-Bush, N. (2020). Smartphones and varsity athletes: A complicated relationship. *Frontiers in Sports and Active Living*, 2, 560031. doi:10.3389/fspor.2020.560031
- Digital Around the World. (2021, April 10). Retrieved from <https://datareportal.com/global-digital-overview>
- Duke, É., & Montag, C. (2017). Smartphone addiction, daily interruptions and self-reported productivity. *Addictive Behaviors Reports*, 6, 90-95. doi:10.1016/j.abrep.2017.07.002
- Dunican, I. C., Martin, D. T., Halson, S. L., Reale, R. J., Dawson, B. T., Caldwell, J. A., . . . Eastwood, P. R. (2017). The effects of the removal of electronic devices for 48 hours on sleep in elite judo athletes. *Journal of Strength and Conditioning Research*, 31(10), 2832-2839. doi:10.1519/JSC.0000000000001697
- Durand-Bush, N., & DesClouds, P. (2018). Smartphones: How can mental performance consultants help athletes and coaches leverage their use to generate more benefits than

drawbacks? *Journal of Sport Psychology in Action*, 9(4), 227-238.

doi:10.1080/21520704.2018.1496211

Dwyer, R. J., Kushlev, K., & Dunn, E. W. (2018). Smartphone use undermines enjoyment of face-to-face social interactions. *Journal of Experimental Social Psychology*, 78, 233-239. doi:10.1016/j.jesp.2017.10.007

Elhai, J. D., Dvorak, R. D., Levine, J. C., & Hall, B. J. (2017). Problematic smartphone use: A conceptual overview and systematic review of relations with anxiety and depression psychopathology. *Journal of Affective Disorders*, 207, 251-259. doi:10.1016/j.jad.2016.08.030

Felisoni, D. D., & Godoi, A. S. (2018). Cell phone usage and academic performance: An experiment. *Computers & Education*, 117, 175-187. doi:10.1016/j.compedu.2017.10.006

Fortes, L. S., Lima-Júnior, D. D., Gantois, P., Nasicmento-Júnior, J. R., & Fonseca, F. S. (2021). Smartphone use among high level swimmers is associated with mental fatigue and slower 100- and 200- but not 50-meter freestyle racing. *Perceptual and Motor Skills*, 128(1), 390-408. doi:10.1177/0031512520952915

Fortes, L. S., Lima-Junior, D., Nascimento-Júnior, J. R. A., Costa, E. C., Matta, M. O., & Ferreira, M. E. C. (2019). Effect of exposure time to smartphone apps on passing decision-making in male soccer athletes. *Psychology of Sport and Exercise*, 44, 35-41. doi:10.1016/j.psychsport.2019.05.001

George, M. J., & Odgers, C. L. (2015). Seven fears and the science of how mobile technologies may be influencing adolescents in the digital age. *Perspectives on Psychological Science*, 10(6), 832-851. doi:10.1177/1745691615596788

Gould, D., Nalepa, J., & Mignano, M. (2020). Coaching generation Z athletes. *Journal of Applied Sport Psychology*, 32(1), 104-120. doi:10.1080/10413200.2019.1581856

- Greco, G., Tambolini, R., Ambruosi, P., & Fischetti, F. (2017). Negative effects of smartphone use on physical and technical performance of young footballers. *Journal of Physical Education & Sport*, 17(4), 2495-2501. doi:10.7752/jpes.2017.04280
- Gui, M., Fasoli, M., & Gerosa, T. (2019). How to tackle smartphone overuse through media education. A randomized controlled trial. *Media Education*, 10(1), 59-68. doi:10.14605/MED1011904
- Jones, M. J., Peeling, P., Dawson, B., Halson, S., Miller, J., Dunican, I., . . . Eastwood, P. (2018). Evening electronic device use: The effects on alertness, sleep and next-day physical performance in athletes. *Journal of Sport Sciences*, 36(2), 162-170. doi:10.1080/02640414.2017.1287936
- Jones, M. J., Dawson, B., Eastwood, P. R., Halson, S. L., Miller, J., Murray, K., . . . Peeling, P. (2019). Influence of electronic devices on sleep and cognitive performance during athlete training camps. *Journal of Strength and Conditioning Research*. doi:10.1519/JSC.0000000000002991
- Hale, L., & Guan, S. (2015). Screen time and sleep among school-aged children and adolescents: a systematic literature review. *Sleep Medicine Reviews*, 21, 50-58. doi:10.1016/j.smr.2014.07.007
- Harris, A., Gundersen, H., Mork-Andreassen, P., Thun, E., Bjorvatn, B., & Pallesen, S. (2015). Restricted use of electronic media, sleep, performance, and mood in high school athletes--a randomized trial. *Sleep Health*, 1(4), 314-321. doi:10.1016/j.sleh.2015.09.011
- Haug, S., Paz Castro, R., Kwon, M., Filler, A., Kowatsch, T., & Schaub, M. P. (2015). Smartphone use and smartphone addiction among young people in Switzerland. *Journal of Behavioral Addictions*, 4(4), 299-307. doi:10.1556/2006.4.2015.037

- Kim, D., Lee, Y., Lee, J., Nam, J. K., & Chung, Y. (2014). Development of Korean smartphone addiction proneness scale for youth. *PloS one*, 9(5), e97920.
- Ko, M., Yang, S., Lee, J., Heizmann, C., Jeong, J., Lee, U., et al. (2015). NUGU: a group-based intervention app for improving self-regulation of limiting smartphone use. *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing* (pp. 1235-1245). doi:10.1145/2675133.2675244
- Korfiatis, N., Stamolampros, P., Kourouthanassis, P., & Sagiadinos, V. (2019). Measuring service quality from unstructured data: A topic modeling application on airline passengers' online reviews. *Expert Systems with Applications*, 116, 472-486. doi:10.1016/j.eswa.2018.09.037
- Kwon, M., Kim, D. J., Cho, H., & Yang, S. (2013). The smartphone addiction scale: development and validation of a short version for adolescents. *PloS one*, 8(12), e83558.
- Li, M., & Lu, L. (2017). The influence of mobile phone addiction on left behind middle school students' sleep quality: The mediator role of loneliness. *Revista Argentina de Clínica Psicológica*, 16(1), 71–82. doi:10.24205/03276716.2017.1006.
- Lochtefeld, M., Bohmer, M., & Ganev, L. (2013). AppDetox: Helping users with mobile app addiction. *Proceedings of the 12th International Conference on Mobile and Ubiquitous Multimedia* (p. 43). doi:10.1145/2541831.2541870
- Montag, C., & Becker, B. (2020). Internet and smartphone use disorder in Asia. *Addictive Behaviors*, 106380. doi:10.1016/j.addbeh.2020.106380
- Ong, J. (2021, Oct 11). The Big Read: Screen time all the time — the unspoken effects of

COVID-19 on digital addiction. *Channel News Asia*.

<https://www.channelnewsasia.com/singapore/screen-time-effects-covid-19-work-home-school-children-technology-2233641>

Panova, T., & Carbonell, X. (2018). Is smartphone addiction really an addiction? *Journal of Behavioral Addictions*, 7(2), 252-259. doi:10.1556/2006.7.2018.49

Przybylski, A. K., Murayama, K., DeHaan, C. R., & Gladwell, V. (2013). Motivational, emotional, and behavioral correlates of fear of missing out. *Computers in Human Behavior*, 29(4), 1841-1848. doi:10.1016/j.chb.2013.02.014

Rajanna, S. H., Sharma, M. K., & Palanichamy, T. S. (2016). Exploration of technology use pattern among teenagers and its relationship with psychological variables. *ASEAN Journal of Psychiatry*, 17(2), 239-249.

Rebold, M. J., Lepp, A., Sanders, G. J., & Barkley, J. E. (2015). The impact of cell phone use on the intensity and liking of a bout of treadmill exercise. *PLoS One*, 10(5), e0125029. doi:10.1371/journal.pone.0125029

Rebold, M. J., Sheehan, T., Dirlam, M., Maldonado, T., & O'Donnell, D. (2016). The impact of cell phone texting on the amount of time spent exercising at different intensities. *Computers in Human Behavior*, 55, 167-171. doi:10.1016/j.chb.2015.09.005

Roberts, M. E., Stewart, B. M., & Tingley, D. (2019). Stm: An R package for structural topic models. *Journal of Statistical Software*, 91(1), 1-40. doi:10.18637/jss.v091.i02

Roberts, M. E., Stewart, B. M., Tingley, D., Lucas, C., Leder-Luis, J., Gadarian, S. K., ... &

Rand, D. G. (2014). Structural topic models for open-ended survey responses.

American Journal of Political Science, 58(4), 1064-1082. doi:10.1111/ajps.12103

- Romyn, G., Robey, E., Dimmock, J. A., Halson, S. L., & Peeling, P. (2016). Sleep, anxiety and electronic device use by athletes in the training and competition environments. *European Journal of Sport Science*, 16(3), 301-308.
doi:10.1080/17461391.2015.1023221
- Ryding, F. C., & Kuss, D. J. (2020). Passive objective measures in the assessment of problematic smartphone use: A systematic review. *Addictive Behaviors Reports*, 11, 100257. doi:10.1016/j.abrep.2020.100257
- Samaha, M., & Hawi, N. S. (2016). Relationships among smartphone addiction, stress, academic performance, and satisfaction with life. *Computers in Human Behavior*, 57, 321-325. doi:10.1016/j.chb.2015.12.045
- Singapore Business Review. (2018). *4.83 million Singaporeans are now online*. Retrieved from <https://sbr.com.sg/information-technology/news/483-million-singaporeans-are-now-online>
- Sohn, S., Rees, P., Wildridge, B., Kalk, N. J., & Carter, B. (2019). Prevalence of problematic smartphone usage and associated mental health outcomes amongst children and young people: a systematic review, meta-analysis and GRADE of the evidence. *BMC Psychiatry*, 19, 356. doi:10.1186/s12888-019-2350-x
- Tamura, H., Nishida, T., Tsuji, A., & Sakakibara, H. (2017). Association between excessive use of mobile phone and insomnia and depression among Japanese adolescents. *International Journal of Environmental Research and Public Health*, 14(7), 701. doi:10.3390/ijerph14070701
- Tan, J. B., & Yates, S. (2011). Academic expectations as sources of stress in Asian students. *Social Psychology of Education*, 14(3), 389-407. doi:10.1007/s11218-010-9146-7
- Terras, M. M., & Ramsay, J. (2016). Family digital literacy practices and children's mobile

- phone use. *Frontiers in Psychology*, 7, 1957. doi:10.3389/fpsyg.2016.01957.
- Ting, C. H., & Chen, Y. Y. (2020). Smartphone addiction. In C. A. Essau & P. H. Delfabbro (Eds.), *Adolescent addiction* (2nd ed., pp. 215-240). Academic Press.
- Tunc-Aksan, A., & Akbay, S. E. (2019). Smartphone addiction, fear of missing out, and perceived competence as predictors of social media addiction of adolescents. *European Journal of Educational Research*, 8(2), 559-566. doi:10.1556/2006.7.2018.32
- van Deursen, A. J. A. M., Bolle, C. L., Hegner, S. M., & Kommers, P. A. M. (2015). Modeling habitual and addictive smartphone behavior: The role of smartphone usage types, emotional intelligence, social stress, self-regulation, age, and gender. *Computers in Human Behavior*, 45, 411-420. doi:10.1016/j.chb.2014.12.039
- Wolniewicz, C. A., Tiamiyu, M. F., Weeks, J. W., & Elhai, J. D. (2018). Problematic smartphone use and relations with negative affect, fear of missing out, and fear of negative and positive evaluation. *Psychiatry Research*, 262, 618-623. doi:10.1016/j.psychres.2017.09.058
- World Health Organization [WHO]. (2015). *Public health implications of excessive use of the internet, computers, smartphones and similar electronic devices*. Meeting report, Main Meeting Hall, Foundation for Promotion of Cancer Research, National Cancer Research Centre, Tokyo, Japan, 27–29 August 2014. Geneva, Switzerland: World Health Organization.
- Yu, S., & Sussman, S. (2020). Does smartphone addiction fall on a continuum of addictive behaviors?. *International Journal of Environmental Research and Public Health*, 17(2), 422. doi:10.3390/ijerph17020422

Figure 1

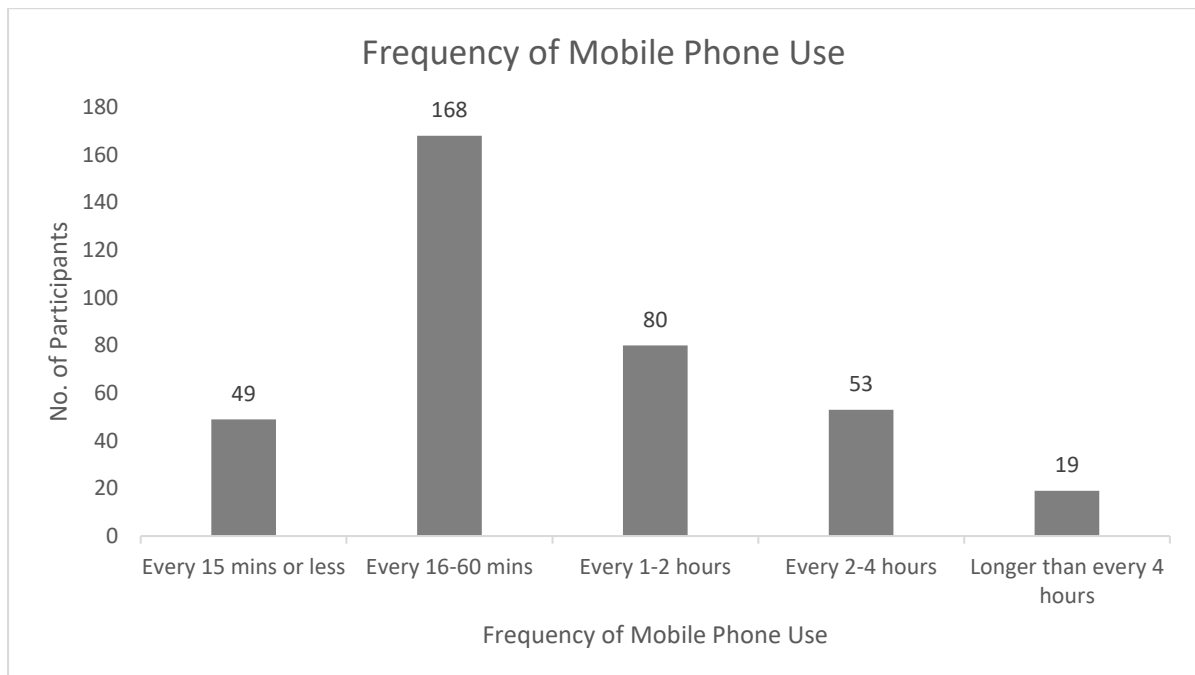


Figure 1. Frequency of mobile phone use among youth athletes

Figure 2

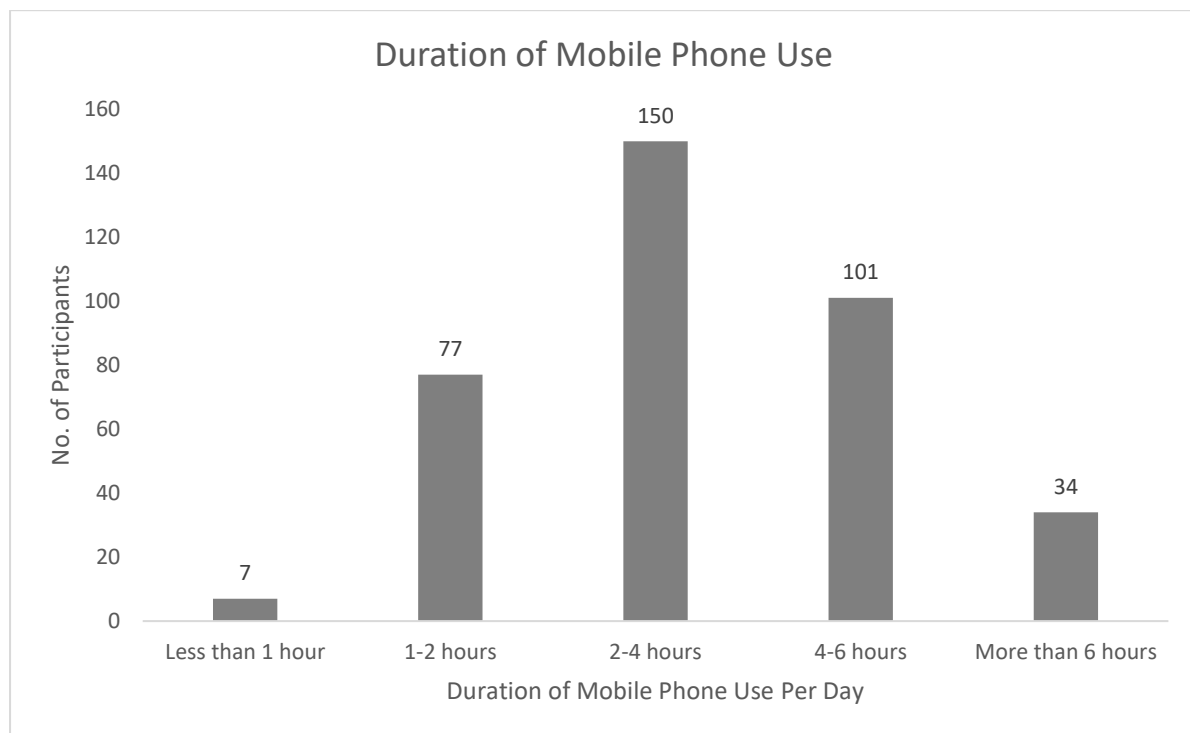


Figure 2. Daily duration of mobile phone use among youth athletes

Appendix A

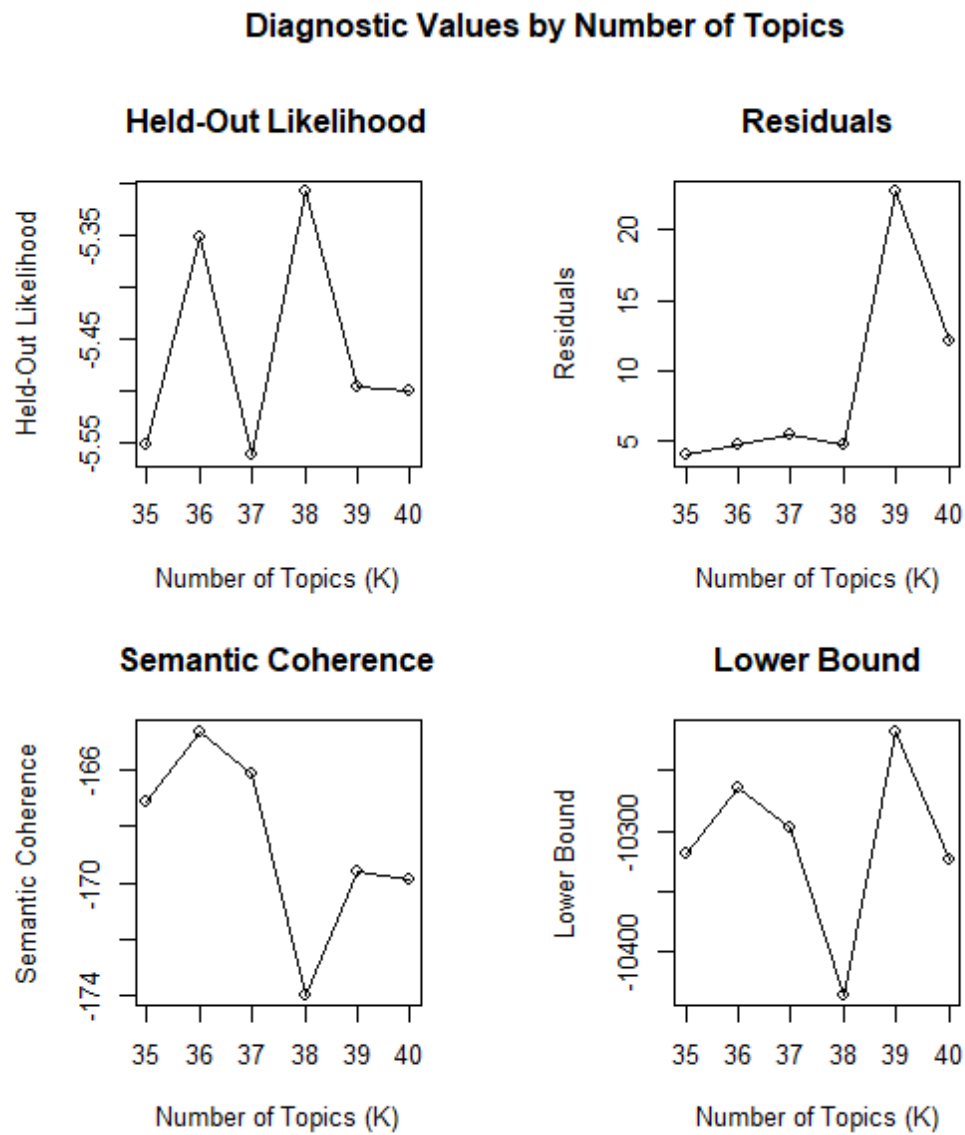
Step-by-step guide for conducting structural topic modelling using stm package

The first step was to use the *textProcessor* and *prepDocuments* functions to prepare the data and ensure that it was in the right format for analysis. This involved the removal of stop words, punctuation, numbers, as well as stemming, normalisation, and tokenisation. The second step was to determine the optimal number of topics (k) for the corpus. A multi-step approach was adopted, borrowing from techniques used in past studies (e.g., Korfiatis et al., 2019; Roberts et al., 2019). The function *searchK* was first employed with $k = 0$ to gain a rough estimation of where the optimal k might reside. Using that initial number as a gauge, a more detailed search of the ranges around that number was conducted, and the optimal k was determined using a combination of the held-out likelihood, residuals, and semantic coherence. Once the optimal k was determined, the structural topic model could be specified and run. Upon running the model, the function *labelTopics* was used to generate a list of topics, as well as the words which best represented those topics. Functions such as *findThoughts*, *plotQuote* and *topicQuality* were also employed to generate further supporting information that would help in the subsequent interpretation and labelling of the topics. The above steps were repeated separately for each of the three open-ended questions that featured in the survey.

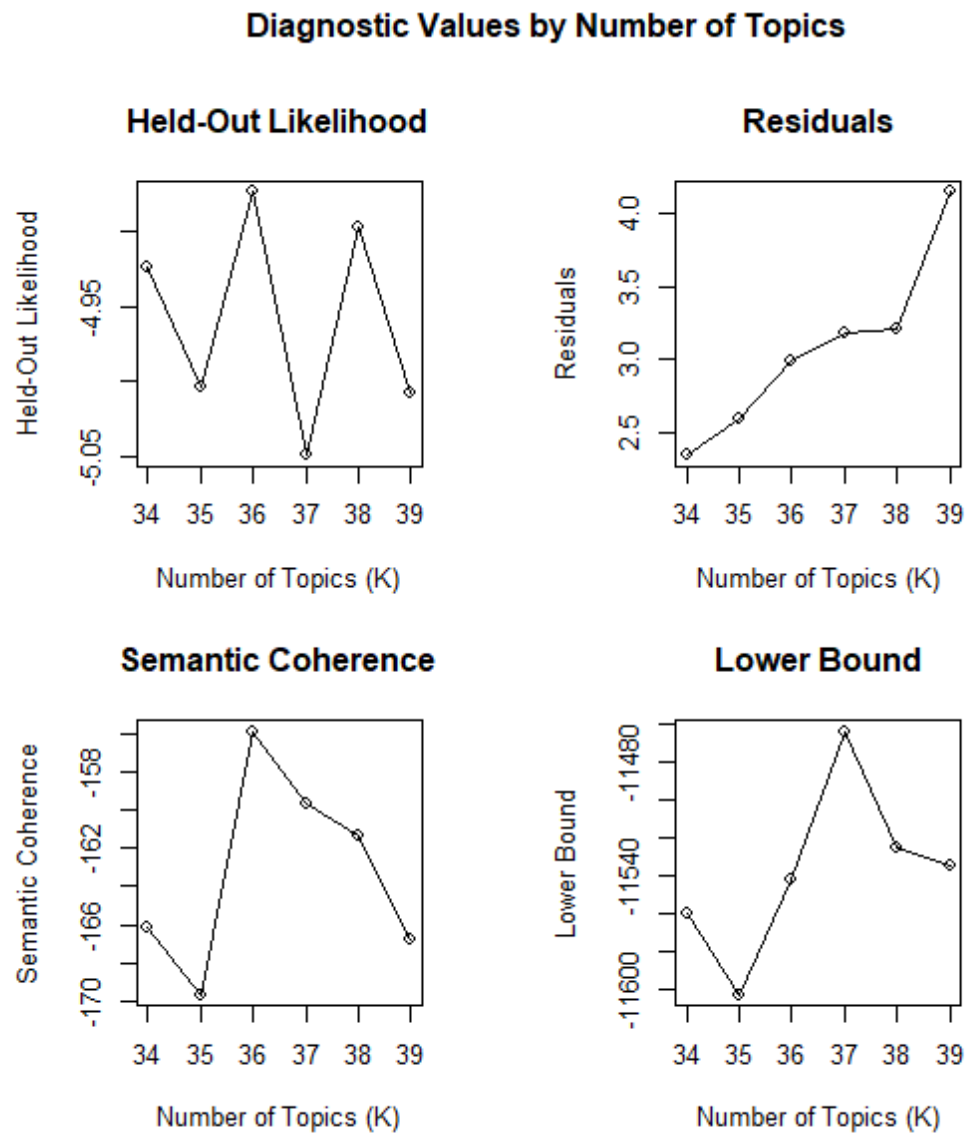
References

- Korfiatis, N., Stamolampros, P., Kourouthanassis, P., & Sagiadinos, V. (2019). Measuring service quality from unstructured data: A topic modeling application on airline passengers' online reviews. *Expert Systems with Applications*, 116, 472-486. doi:10.1016/j.eswa.2018.09.037
- Roberts, M. E., Stewart, B. M., & Tingley, D. (2019). Stm: An R package for structural topic models. *Journal of Statistical Software*, 91(1), 1-40. doi:10.18637/jss.v091.i02

Appendix B

Diagnostic values for optimal number of topics (k)

Appendix B Figure 1. Diagnostic values for optimal k for Question 1 (Factors)



Appendix B Figure 2. Diagnostic values for optimal k for Question 2 (Effects)

Appendix C

List of topics for question 1 (Factors)

Topic	Highest probability words	FREX words	Topic proportions
<i>Habitual / compulsive use</i>			
32 (Constant urge to check everything)	check, see, constant, urg, everi, need, platform	check, everi, see, urg, constant, desir, sure	4.02%
25 (Want to continue)	want, continu, make, updat, happen, drama, convers	continu, want, happen, updat, drama, seri, convers	3.47%
26 (Missing important things)	miss, import, friend, new, stay, inform, present	miss, import, stay, new, present, turn, inform	2.95%
37 (Engrossed)	will, get, watch, show, engross, text, start	will, engross, show, abl, watch, get, text	2.53%
9 (Addiction)	addict, absenc, activ, sometim, instagram, phone, game	absenc, addict, instagram, form, parent, around, spend	2.44%
34 (Habitual use)	habit, use, time, phone, also, slight, sometim	habit, slight, increas, use, whatev, sometim, form	2.40%
27 (Become habit / FOMO)	becom, fomo, even, life, parent, think, much	becom, fomo, even, life, allow, parent, differ	1.74%
<i>Accessibility / utility</i>			
5 (Phone always available for use)	phone, use, alway, lead, hour, conveni, ring	alway, use, phone, ring, conveni, lead, hour	6.12%
4 (Notifications)	notif, think, day, sound, pop, work, make	sound, notif, think, pop, addit, curios, day	4.24%
16 (Everything is online)	onlin, everyth, now, use, frequent, watch, etc	everyth, onlin, now, frequent, devic, etc, life	1.88%
3 (Scrolling)	scroll, tiktok, get, time, carri, stop, track	tiktok, scroll, carri, away, track, lose, lost	1.86%
36 (Ease of access)	especi, use, access, set, easi, session, becom	especi, access, easi, huge, set, session, becom	1.58%
22 (Access)	access, use, read, inform, keep, also, sometim	read, access, inform, sinc, quit, keep, class	1.11%
<i>Entertainment</i>			
21 (Netflix shows)	netflix, show, watch, late, differ, will, drama	netflix, show, late, night, differ, watch, mind	3.76%
31 (Media)	media, lot, probabl, inabl, post, often, mean	probabl, media, inabl, post, lot, often, contact	2.97%
15 (Social media stuff)	social, stuff, tri, depend, media, frequent, escap	stuff, tri, social, depend, frequent, pressur, problem	2.80%
35 (Gaming)	game, mani, sometim, chat, can, spend, instagram	game, chat, mani, sometim, throughout, can, instagram	2.51%
28 (Watch videos)	video, play, watch, youtub, music, keep, contact	play, video, music, youtub, watch, contact, keep	1.68%
<i>Alleviation of boredom / moods</i>			
12 (Free time / procrastination)	time, much, procrastin, long, free, kill, day	much, procrastin, free, time, long, day, kill	3.45%
29 (Nothing better to do / laziness)	also, noth, just, home, lazi, better, pass	noth, lazi, better, also, home, just, els	3.28%
8 (Alleviation of boredom / entertainment)	boredom, entertain, temptat, function, possibl, avail, lead	temptat, entertain, boredom, function, possibl, funni, anyth	2.98%
13 (Being alone)	bad, alon, fun, just, phone, kind, realis	bad, fun, alon, kind, realis, just, wast	2.28%
17 (Moods / boredom)	bore, mobil, feel, mani, get, moodi, avail	mobil, bore, moodi, mani, feel, avail, get	1.78%
<i>Communication</i>			
18 (Receiving messages)	messag, may, receiv, caus, home, factor, contribut	messag, receiv, may, caus, home, factor, provid	2.49%

7 (Need to reply people quickly)	peopl, repli, get, want, group, quick, dont	repli, peopl, group, quick, respond, dont, wait	2.35%
1 (Texting / talking to friends)	friend, text, talk, prefer, sometim, instagram, keep	friend, text, prefer, talk, level, pressur, funni	2.01%
14 (Way of communication)	need, way, communic, sometim, keep, realiti, escap	way, communic, need, interact, escap, realiti, keep	1.89%
<i>Lack of control</i>			
24 (Lack of self-discipline / control)	lack, self, disciplin, sleep, control, focus, cant	sleep, disciplin, self, lack, manag, control, cant	3.71%
23 (Distraction)	distract, stop, get, activ, easili, class, work	distract, activ, easili, stop, ill, physic, class	3.08%
2 (Tiredness / losing track of time)	time, tire, track, feel, enough, eye, want	tire, track, enough, eye, time, feel, lose	1.87%
6 (No time limit on app / phone usage)	app, find, usag, limit, control, phone, connect	app, usag, find, connect, control, limit, excess	1.62%
<i>Cope with school / work</i>			
11 (De-stress from work)	work, fear, thing, destress, school, interest, certain	fear, work, destress, thing, certain, school, interest	4.62%
33 (Stress relief from school)	stress, use, phone, reliev, relax, exam, school	stress, reliev, exam, relax, schoolwork, use, school	3.00%
30 (Take a break from studying)	studi, break, take, can, often, howev, sport	studi, take, break, sport, travel, can, howev	1.64%
<i>Unclear</i>			
20	famili, look, poor, train, exampl, someth, boredom	poor, famili, exampl, look, train, mayb, someth	3.42%
19	like, feel, updat, need, make, get, see	like, updat, feel, listen, need, besid, see	2.35%
10	one, might, new, peer, also, look, find	might, one, peer, new, current, look, also	1.34%
38	phone, extra, keep, also, sometim, time, use	extra, phone, pressur, often, spend, person, lot	0.79%

Appendix D

List of topics for question 2 (Effects)

Topic	Highest probability words	FREX words	Topic proportions
<i>Time wastage / insufficient time</i>			
30 (Time wastage)	time, wast, track, lose, like, schedul, spent	wast, time, track, spent, effici, like, lose	6.23%
35 (Longer breaks)	feel, day, workout, can, next, break, longer	day, break, longer, workout, feel, next, can	2.54%
24 (Lesser time)	lesser, rest, thing, time, screen, control, reaction	lesser, thing, rest, screen, reaction, time, control	2.43%
21 (Laziness)	lazi, feel, sometim, also, make, amount, mani	lazi, feel, potenti, mani, amount, anyth, forget	2.01%
34 (Cause procrastination)	caus, procrastin, train, daili, motiv, hurt, carri	caus, daili, procrastin, motiv, hurt, train, carri	2.01%
8 (Poor time management)	time, manag, set, rest, lost, poor, workout	manag, set, lost, time, poor, cut, gym	1.53%
1 (Get away from priorities)	get, prioriti, angri, phone, realli, check, forget	get, prioriti, away, music, scold, demotiv, quick	1.51%
12 (Less time to do stuff)	less, activ, stuff, busi, schedul, train, already	less, stuff, activ, busi, around, leav, normal	1.23%
<i>Distraction / loss of focus</i>			
32 (Easily lose focus)	focus, lose, easili, self, train, tend, phone	focus, easili, self, lose, tend, negat, mood	3.14%
11 (Tired / lose concentration)	tire, concentr, make, loss, limit, wont, juggl	tire, loss, concentr, wont, limit, make, juggl	3.06%
25 (Shorter attention span / lesser productivity)	product, level, attent, span, reduc, will, decreas	span, product, attent, level, reduc, shorter, slack	2.81%
27 (Inability to complete tasks)	task, watch, show, complet, inabl, hand, will	task, watch, inabl, show, hand, complet, afternoon	2.79%
14 (Studying)	studi, even, hour, usual, already, time, train	even, studi, already, hour, usual, though, student	2.14%
3 (Want to use phone instead)	want, instead, can, exercis, phone, done, dont	instead, want, done, realli, depend, say, stuck	2.10%
33 (Think / worry about something else)	make, think, distract, someth, lose, play, angri	think, someth, angri, whenev, worri, make, play	1.97%
<i>Sport-related</i>			
10 (Poor performance)	train, perform, lead, well, result, will, competit	perform, lead, result, well, disciplin, train, competit	6.24%
6 (Drop in training quality)	train, may, spend, drop, also, distract, competit	may, drop, spend, train, grade, competit, also	3.75%
29 (Distraction from sport)	distract, sport, eyesight, play, devic, howev, usag	sport, distract, devic, eyesight, howev, play, usag	3.07%
19 (Don't exercise in free time)	exercis, free, lot, need, don't, will, procrastin	free, exercis, lot, don't, need, engross, rather	2.68%
7 (Lack of recovery)	enough, lack, littl, recoveri, vision, hour, around	lack, enough, littl, recoveri, vision, hour, around	2.65%
31 (Unable to concentrate on game)	game, unabl, peopl, abl, train, concentr, also	game, peopl, unabl, abl, fulli, interact, main	1.49%
36 (Training)	train, just, phone, time, can, like, distract	just, train, muscl, forget, usag, delay, actual	0.91%
<i>Sleep / tiredness</i>			
4 (Worsened sleep)	sleep, eyesight, worsen, train, import, will, time	sleep, worsen, eyesight, around, negat, thus, music	2.96%
20 (Stay up late)	late, night, homework, stay, day, next, often	stay, late, homework, night, quit, finish, often	2.73%
17 (Lethargy)	end, phone, letharg, run, put, suppos, use	letharg, run, end, harder, suppos, put, plan	2.12%

28 (Wake up early)	train, wake, earli, will, swim, due, need	earli, swim, wake, read, best, need, occasion	2.08%
2 (Drain energy from work / training)	work, train, make, session, drain, finger, possibl	work, drain, finger, possibl, session, make, prevent	2.04%
26 (Eye tiredness)	eye, train, tired, may, will, henc, distract	eye, tired, henc, may, long, best, will	1.39%
18 (Sleep later / low energy)	later, due, energi, bad, toward, low, youtub	later, energi, low, due, youtub, toward, bad	1.32%
<i>Addiction</i>			
16 (Addiction)	addict, check, keep, can, bit, amount, train	addict, keep, check, bit, can, amount, negat	4.64%
<i>Unclear</i>			
23	sometim, much, put, night, hard, handphon, match	sometim, much, put, handphon, hard, night, hurt	6.56%
9	abl, can, long, cant, proper, phone, tend	abl, cant, proper, long, blue, tend, etc	5.56%
22	phone, use, continu, skip, control, tend, immedi	continu, use, phone, skip, control, immedi, tend	4.47%
15	social, train, media, one, can, skill, class	social, media, skill, one, happen, class, can	2.66%
5	affect, might, train, problem, strain, sight, muscl	might, affect, problem, strain, train, sight, muscl	1.72%
13	dont, much, alway, athlet, think, mobil, problemat	dont, alway, athlet, much, messag, problemat, practic	1.49%