ASSESSING THE STATE ANXIETY, HEART RATE RESPONSES, AND PERFORMANCE DURING E-BOWLING GAME IN MALE ANDFEMALE INDIVIDUALS

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By

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LIST OF ABBREVIATIONS

BPM   Beats Per Minute

CSA   Cognitive State Anxiety

CSAI-2   Competitive State Anxiety Inventory-2

CSAI-2R   Competitive State Anxiety Inventory-2 Revised

E-Bowling   Electronic Bowling

E-Sport   Electronic Sport

HR   Heart Rate

SSA   Somatic State Anxiety

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ASSESSING THE STATE ANXIETY, HEART RATE RESPONSES, AND PERFORMANCE DURING E-BOWLING GAME IN MALE AND FEMALE INDIVIDUALS

ABSTRACT

Introduction: Psychological changes is a common situation in a sport performance, including anxiety that may cause changes in other physiological responses. Increased state anxiety can be related to increased heart rate and this could affect performance. In E-sports, anxiety can include repetitive thought loops, especially about things a person cannot complete in the game. The purpose of the present study is to assess the state anxiety, heart rate responses and performance during E-bowling game in male and female individuals. **Method:** 26 participants were grouped into male group (n = 13) and female group (n = 13). The participants played two games of E-bowling game downloaded in their smartphone. In each game, the participants answered the Revised Competitive State Anxiety Inventory-2 (CSAI-2R) 10 minutes before the E-bowling game starts and recorded their heart rate two minutes before the E-bowling game starts. The performance was recorded as a total score (pin drops) from the two games. **Results:** There were significant differences in the somatic state anxiety for male and female participants (p=0.025). There were no significant differences in cognitive state anxiety, heart rate and performance between male and female participants. **Conclusion:** Female participants showed a higher mean score of all the variables compared to male participants during E-bowling game.

PENILAIAN KEBIMBANGAN SEMASA, KADAR DENYUTAN JANTUNG, DAN PRESTASI SEMASA PERTANDINGAN DALAM INDIVIDU LELAKI DAN PEREMPUAN YANG BERMAIN PERMAINAN E-BOLING

ABSTRAK

Pendahuluan: Perubahan psikologi adalah situasi kebiasaan yang berlaku dalam sukan termasuklah kebimbangan yang menyebabkan perubahan tindak balas fisiologi yang lain. Peningkatatan kebimbangan boleh dikaitkan dengan peningkatan kadar denyutan jantung dan ia boleh menganggu prestasi sukan. Dalam E-sukan, kebimbangan boleh merangkumi pemikiran yang berulang, terutama mengenai perkara yang tidak dapat diselesaikan oleh seseorang dalam permainan. Tujuan kajian ini adalah untuk menilai kebimbangan keadaan, tindak balas degupan jantung dan prestasi semasa permainan E-bowling pada individu lelaki dan wanita. **Kaedah**: 26 peserta dibahagikan kepada kumpulan lelaki (n = 13) dan kumpulan wanita (n = 13). Semua peserta bermain dua kali permainan E-bowling dimuat turun dalam telefon pintar. Pertama, peserta memuat turun permainan E-bowling di telefon pintar mereka. Kemudian, para peserta menjawab Revised Competitive State Anxiety Inventory-2 (CSAI-2R) 10 minit sebelum permainan dimulakan dan mencatat kadar denyutan jantung mereka dua minit sebelum permainan dimulakan. Prestasi peserta dicatat sebagai skor keseluruhan (jatuhan pin) dari kedua-dua permainan. **Keputusan**: Terdapat perbezaan yang signifikan dalam kebimbangan somatik antara individu lelaki dan wanita dengan nilai (p = 0.025). Tidak ada perbezaan yang signifikan dalam kebimbangan kognitif, degupan jantung dan prestasi antara peserta lelaki dan wanita yang bermain E-bowling. **Kesimpulan**: Peserta perempuan menunjukkan skor min yang lebih tinggi dari semua pemboleh ubah berbanding lelaki semasa bermain E-boling.

CHAPTER 1

INTRODUCTION

Background of the study

Anxiety refers to the physical, behavioral, emotional, and cognitive effects one experiences while undergoing a particular situation. Anxiety is a subjective matter and can even be triggered by insignificant events. The American Psychological Association (APA, 2000) defines anxiety as an emotion characterized by feelings of tensions, worried thoughts and physical changes like increased blood pressure or heart rate. Anxiety is a subjective and it can be triggered by either significant or insignificant events, either it is clearly seen or appear in an individual's mind. Experiencing anxiety may negatively affect an athlete's performance, for example itmay reduce attention and ability to analyse a game situation, which further causes a decline in the athletes' performances. The effects of this may lead to a drastic declinein the player's or the individual's performance.

There are a few theories have been proposed to explain the relationship between anxiety and sports performance. For example, the Inverted-U hypothesis by Yerkes and Dodson introduced in the year 1908 posited that the performance increases with increasing physiological or mental arousal/anxiety, but it occurs only up to a certain level, and when the level of arousal/anxiety becomes too high, performance decreases. The Inverted-U-hypothesis shows a bell-shaped curve, denoting that low or high arousal/anxiety level are often associated with poor sports performance. In practical, athletes are recommended to regulate their anxiety/arousal to the moderate level in order to produce a good performance.

Moreover, the state of anxiety can be classified into cognitive and somatic anxiety. Both types of anxiety can affect sports performance. In sports, increased levelof anxiety sometimes leads to a choking, a situation in which an athlete delivers poorperformance when under stress or pressure. Stress often occurs in athletes before thegame day or even during the game because of internal and external factors such as the presence of the audience and high expectations to perform well in the competition.In addition, it is common to see that fear of injury, presence of an audience, unpleasantperformance history, fear of losing negative evaluations, knowledge of the opposingteam, performance doubt, importance of a game are identified as causes of anxiety among athletes. The occurrence of anxiety is common in sports regardless of any typeof athletes' level, either amateur or elite athletes (Wilson & Roland, 2002). Moreover,anxiety leads to changes in bodily responses such as heart rate, blood pressure, and muscle activity that can affect motor performance. Athletes with anxiety typically experience a deterioration in their motor skill execution and resulted in poor performance (Weinberg & Gould, 2010; Raglin & Hanin, 2000). Therefore, the implementation of psychological skill training is crucial for athletes to overcome themselves when anxiety heightens.

Heart rate has a significant relationship with anxiety. Males and females havea slightly different resting heart rate reading. An average adult's heart rate is between70 to 85 beats per minute, with a significant variance was reported between genders.Adult males have a heart rate of 70 to 72 beats per minute, whereas adult females have a heart rate of 78 to 82 beats per minute (Prabavathi & Tamarai,2014). Because the female heart pumps less blood with each beat, it must beat quicker to match the output of the larger male heart (Prabavathi & Tamarai,2014). Furthermore, the pacemaker in women's hearts has a different intrinsic rhythmicity, causing them to beat quicker. Accordingly, there is a linear association between

the state anxiety andheart rate response towards an athlete's performance. That is, increased state anxietyleads to an increased heart rate response that could affect performance if it is perceived negatively.

Electronic sport (E-sport) is a type of video game competition. E-sport is a term that is used to describe the casual or organized playing of video games in a waythat it provides professional or personal development to the player (Pedraza-Ramirezet al., 2020). E-sports has become increasingly popular and gained attention from researchers (Reitman et al., 2020). Jenny et al. (2017) identified that E-sports is fittedwell within the sociological and philosophical definitions of sport, in which it involves play, competition, and skills. Interestingly, E-sport and sports provideentertainment to the audience who is viewing the game, as they are both involve competitive environments and the player displays their skills, talents, and tactics. Ona psychological aspect, it has been suggested that the competitive and supportive nature of E-sports requires same mental skills as traditional sports (Murphy, 2009; Campbell et al., 2018). For example, individuals playing E-sports and sports need todisplay high level of sustained attention and they have to make important decisions under time constraints.

There are various types of E-sports that can be played using various devices such as video games console, computers or even mobile phones. The most common E-sports are FIFA soccer games, and NBA basketball games. With regards to electronic bowling games (E-bowling), although it is not as popular as FIFA or NBAgames, playing E-bowling provides challenges to the players, yet it does not require high skills for most people to play. Playing E-bowling has a similar objective with playing bowling in a real setting, in which players aim to obtain a strike in every single frame and high score (total pin drops) for every game they play. However, players who are playing E-bowling do not need to execute physical skills

such as strength, flexibility, balance and coordination, which are needed for a successful bowling performance. Nevertheless, both E-bowling and bowling involves the use of players' cognitive function, such as hand and eye coordination, particularly whenplayers are looking at the target pins and arrows on the lane,and they are aligning their body onto a correct position.

The state anxiety may fluctuate from low to high level, as being discovered inmany sports situations including E-sports. Thus, examining recreational players response physiologically and psychologically during E-bowling games is an interesting topic to explore, particularly when the activity is performed for a casual purpose.

Problem statement

As the theory suggests, when the anxiety level increases, the performance of athletes drops, however it is not the case in all sporting situations. Pre-competition anxiety may cause athletes to feel worry and haveirrelevant thoughts. Also, they may experience biological symptoms related to anxiety such as increased heart rate. In addition, many individuals who playrecreational sports do not know the way they can regulate their anxiety despitethey want to perform well in the game. In E-sports, anxiety can include repetitive thought loops, especially about things a person cannot complete inthe game. It can also be more than the failure to complete a game or win or even get a high score. Players can feel disappointed if they could not control their anxiety or having low scores.

Objective of study

The general objective of this study is to assess the state anxiety, heart rate andperformance of male and female individuals playing e-bowling. The specificobjectives are as below:

1) To examine the pre-competition somatic state anxiety and cognitive stateanxiety of male and female individuals playing e-bowling.

2) To examine the pre-competition heart rate of male and female individualsplaying e-bowling.

3) To examine the performance of male and female individuals playing e-bowling.

Hypothesis of the study

H_0:^{1} There is no significant difference for somatic state anxiety between male and female recreational e-bowling individuals.

H_1:^{1} There is a significant difference for somatic state anxiety and cognitive state anxiety between male and female recreational e- bowling individuals.

H_0:^{2} There is no significant difference for cognitive state anxiety between male and female recreational e-bowling individuals.

H_1:^{2} There is a significant difference for cognitive state anxiety between male and female recreational e-bowling individuals.

H_0^{3}: There is no significant difference for heart rate between male andfemale recreational e-bowling individuals.

H_1^{3}: There is a significant difference for heart rate between male and female recreational e-bowling individuals.

H_0^{4}: There is no significant difference for perfomance between male and female recreational e-bowling players.

H_1^{4}: There is a significant difference for perfomance between male andfemale recreational e-bowling players.

Significance of the study

The players will understand that changes in anxiety level before and during the game could influence their performance. Performing well in the game can enhance motivation and make the playing experience more enjoyable, although the task is not highly competitive. In practical, data on thestate anxiety and heart rate may help the players to find any appropriate psychological technique to overcome anxiety related symptoms. Obtaining agood score can increase motivation for the players. Players can also know when they are having anxiety and how to overcome it with appropriate psychological methods.

CHAPTER 2

LITERATURE REVIEW

When reviewing anxiety in sports competitions, one of the questions is about how anxiety influences athletic performance. Successful athletes tend to use their anxiety as a stimulant for a better performance, whereas less successful athletes seem to experience anxiety, self-doubt and the perception of failure. In sports, anxiety may influence performance because the physical demands of the task often are the necessity of an optimal physiological state of readiness for the best possible performance.

The Inverted-U hypothesis is a popular model to describe the arousal performance relationship. Studies concluded that the Inverted-U hypothesis shows optimal performance on the simple task was seen at 60 and 70% of maximum arousal. Furthermore, for the simple task used in this study, only somatic anxiety as measured by the Sport Anxiety Scale (SAS) accounted for significant variance in performance beyond that accounted for by arousal alone (Shawn & Daniel, 2003). This theory helps to understand the athletes' state anxiety and how it influences their performance. The correlation exists between state anxiety and performance, where an athlete feels physiological changes, such as, increases in the levels of muscle tension, nervousness, and heart rate. The correlation between state anxiety, where an athlete feels physiological changes, such as, increases in the levels of muscle tension, nervousness, heart rate and performance is however, similar to the inverted u theory.

Moreover, the Individual Zones of Optimal Functioning (IZOF) model (Hanin, 2002) is also proposed to explain the effects of anxiety to athletic performance. According to Hanin (2002), the level of competitive anxiety that is optimal to achieve good performance is

subjective. In addition, the attention control theory posits that that increased anxiety leads to an impaired attentional control, leading to a performance reduction by involving the central function of the working memory system (Coombes et al., 2009). Finally, another theory framework is the Multidimensional Theory of Competitive Anxiety (Martens et al., 1990) that separates competitive anxiety into three dimensions which are cognitive anxiety, somatic anxiety, and self-confidence. According to this theory, cognitive anxiety occurs when individuals have negative thoughts, expectations, or self-verbalizations concerning the competitive event. Somatic anxiety refers to the affective and physiological elements that directly affect the central nervous system (sympathetic), thus activates the physiological responses to adapt in a demanding situation. Fazey and Hardy (1988) proposed the Inverted-U Hypothesis, known as the Catastrophe Theory, which clarifies the relationship between the different anxiety components and performance. The model proposed that cognitive anxiety acts as a splitting factor which determines if the effects of physiological arousal are small and smooth, large and catastrophic, or maybe somewhere between those two extremes. When individuals are in a demanding situation, increased somatic anxiety can be characterised by excessive bodily symptoms such as pain, weakness, or shortness of breath, which causes substantial distress and/or impairment in functioning. Self- confidence is related to the level of confidence and perceived readiness to compete (Martens et al., 1990).

Anxiety in the other hand consists of two parts which is focused which are somatic state anxiety and cognitive state anxiety. Somatic symptom disorder is characterised by a person's excessive emphasis on bodily symptoms such as pain, weakness, or shortness of breath, which causes substantial distress and/or impairment in functioning. Excessive thoughts, sentiments, and behaviours are associated with the physical symptoms. Cognitive

anxiety may be caused by negative thoughts created by the person about himself or herself (Selim,2016). Other than that, somatic anxiety expresses itself with a person's physical symptoms (Lane et al., 1999).

Questionnaire has been widely used among researchers to assess cognitive state anxiety and somatic state anxiety is largely used among researchers in studies involving athletes. For example, the Competitive State Anxiety Inventory–2 (CSAI–2) and Revised Competitive State Anxiety Inventory–2 (CSAI–2R) is an instrument used to measure anxiety before a competition or when an athlete is performing. The CSAI–2 takes its place among the measurement methods for competitive anxiety, thus, it is the most well-known tool (Martens et al., 1990; Woodman & Hardy, 2003).This finding supports that different gender or age of a person affects the state anxiety of the person. Self-confidence, in the multidimensional anxiety theory of (Martens, et al.1990), is assumed to have a positive linear relation with athletic performance (Tsopani et al., 2011). Modroño & Guillen, (2010) reported a significant and negative relationship between age and cognitive anxiety, and this may have been because of the older athletes had more experience than the younger athletes. Also, they found that different gender or age of a person affects the state anxiety of the person.

Wild et al. (2008) reported that individuals who perceive their heart rate is increasing, reported greater anxiety and physical signs of anxiety measured with the autonomic perception questionnaire. This result was reliable across both high and low anxiety groups, showing that individuals with greater heart rate were likely to experience increased anxiety levels (Wild et al., 2008). This shows that perceived rather than actual heart rate is likely to be more strongly associated with anxiety responses to stress and this shows that the athlete cannot perform at their peak. This shows that perceived rather than actual heart rate is likely to be more strongly associated with anxiety

responses to stress and this shows that the athlete cannot perform at their peak. Heart rate measures can reflect aerobic based adaptation and fatigue status ofathletes (Buchheit,2014). It is also showed that in competitive sports, the influence oftraining plays a major role in autonomic nervous system status changes and, therefore,heart rate measures might be able to represent the athlete's training status (Lambertset al., 2010). The average resting adult male heart rate is between 70 and 72 beats perminute, while the average for adult women is between 78 and 82 beats. Thisdifference is the clue to the size of the heart, which is typically smaller in females than males (Prabavathi et al., 2014). It is also showed in a different study that in competitive sports, the influence of training plays a major role in autonomic nervous system status changes and, therefore, heart rate measures might be able to represent the athlete's training status (Lamberts et al.2010).A research shows that elevated heartrates has been observed immediately prior to the start and during a chess match (Troubat et al., 2009). It is suggested that the increased heart rate could indicate a stressreaction to a competition even when physical activity is not involved (Troubat et al.,2009). In a study involving an E-sports, a peak heart rate of 160–180 bpm was observed when playing League of Legends tournament more than 30 minutes of play (Frobose, 2017). This study indicates that the longer playing time could potentially come out with a greater physiological response to e-sports players. From these researches it is safe to say that the longer playing time could potentially come out with a greater physiological response to e-sports players.

Hence, the purpose of the present investigation was to assess the heart rate, anxiety, and performance during recreational e-bowling athletes during a competition. Results from this study may provide information for individuals psychological conditions and improve their game performance should they intend toparticipate competitively.

CHAPTER 3

METHODS

Study Design

This study applied a quasi-experimental study design that involved two groups of male and female participants. Participants in both groups were engaged in an experiment, in which they were required to play E-bowling game consisted of two games.

Participants

The sampling method used in this study was purposive sampling. The potential participants were selected based on the inclusion criteria including male and female individuals, have no chronic illness that affect their heart rate response, have no severe physical injuries and have some experience playing any E-sports. Those who had chronic illness that affect the HR response (cardiorespiratory), had severe physical injuries, and had no experience at all in playing e-sport were excluded.

Sample size calculation

The number of participants were determined based on the sample size calculation. The confidence level set for this research was 95% with a margin of error at 5%. The population proportion used was 50%, hence, the suggested sample size for this research is 11. Considering 20% drop out, the expected sample size for each group was 13 participants.

Participant recruitment and location of data collection

Participants were recruited via social media, such as WhatsApp and Facebookand by using a word of mouth. The data collection was done synchronously accordingto gender group (one researcher with three or four participants) using an online platform called Webex meet.

Research Instrument

The Revised-Competitive State Anxiety Inventory 2R (CSAI-2R; Cox et al., 2003).

The CSAI-2R in English language were used to measure the state anxiety. This questionnaire is a revised 17 item questionnaire consisting of three subscales; Cognitive anxiety, Somatic Anxiety and Self-Confidence. However, only cognitive anxiety and somatic anxiety subscales were taken considering the objectives of this study. Participants were asked to indicate "how you feel right now" for each item on a 4-point Likert scale ranging from "not at all" to "very much so. The sub-scale score is obtained by summing, dividing by the number of items and multiplying by 10. Score range is 10 to 40 for each subscale.

Smart watch with heart rate function.

A smart watch (e.g., Apple Smart Watch Series 3, Xiaomi Band 4 and 5 and Realme Watch S) that consists of a function to assess the HR were used to record theHR. To measure the HR, first, participants were asked to wear a HR smart watch on their wrist. Then, they were asked to monitor the HR themselves and report the HR reading (in beats per minute) to the researcher. The smart watch has been used widely to assess the HR, including in some previous studies for example Falter et.al (2019) stated in his study that it might be considered

safe to incorporate the Apple Watch inHR-guided training programs in the setting of cardiac rehabilitation. Another showedthat, the accuracy of smart watch such as Apple watch 3 and Fitbit Charge 2 were generally highly accurate across the 24-hour condition (Nelson et al.2019).

E-bowling Game Apps.

The online application used to play the E-bowling game was the Bowling 3DExtreme (B3D EXTREME, Sailendu Behera) which is available and can be downloaded in the Apple Apps Store and Google Play Store on their mobile phones.The participants were asked to download the application on their own mobile phones.

Study Procedure

Due to the Pandemic Covid-19's restriction, all the data collection process was carried out using an online platform. Researcher was located in Universiti SainsMalaysia (USM) Health Campus and the participants were at their respective residences. One day before the test day, the researcher emailed an information consent form and CSAI-2R questionnaire to the participants. Researcher asked the participants to return the consent form on the same day after they have signed it. Also,participants were reminded to be ready in front of computer at a set time.

On the test day, the researcher called the participants using a Webex meeting programme. First, participants downloaded the E-bowling game on their smartphone.Then, participants answered the CSAI-2R 10 minutes before the game start and recorded their HR two minutes before the game starts. Researcher first explained to participants about how

to play the game and allow them to try playing the game for a few times. In the game, participants played two single player games that consist of 10 frames in each game. After finishing the first game, participants answered the CSAI-2R and recorded their HR again before commencing the second game. Finally, after finished the game, participants' performance was recorded as a total score (pin drops) from the two games. Researcher thanked all participants for their involvement in the study.
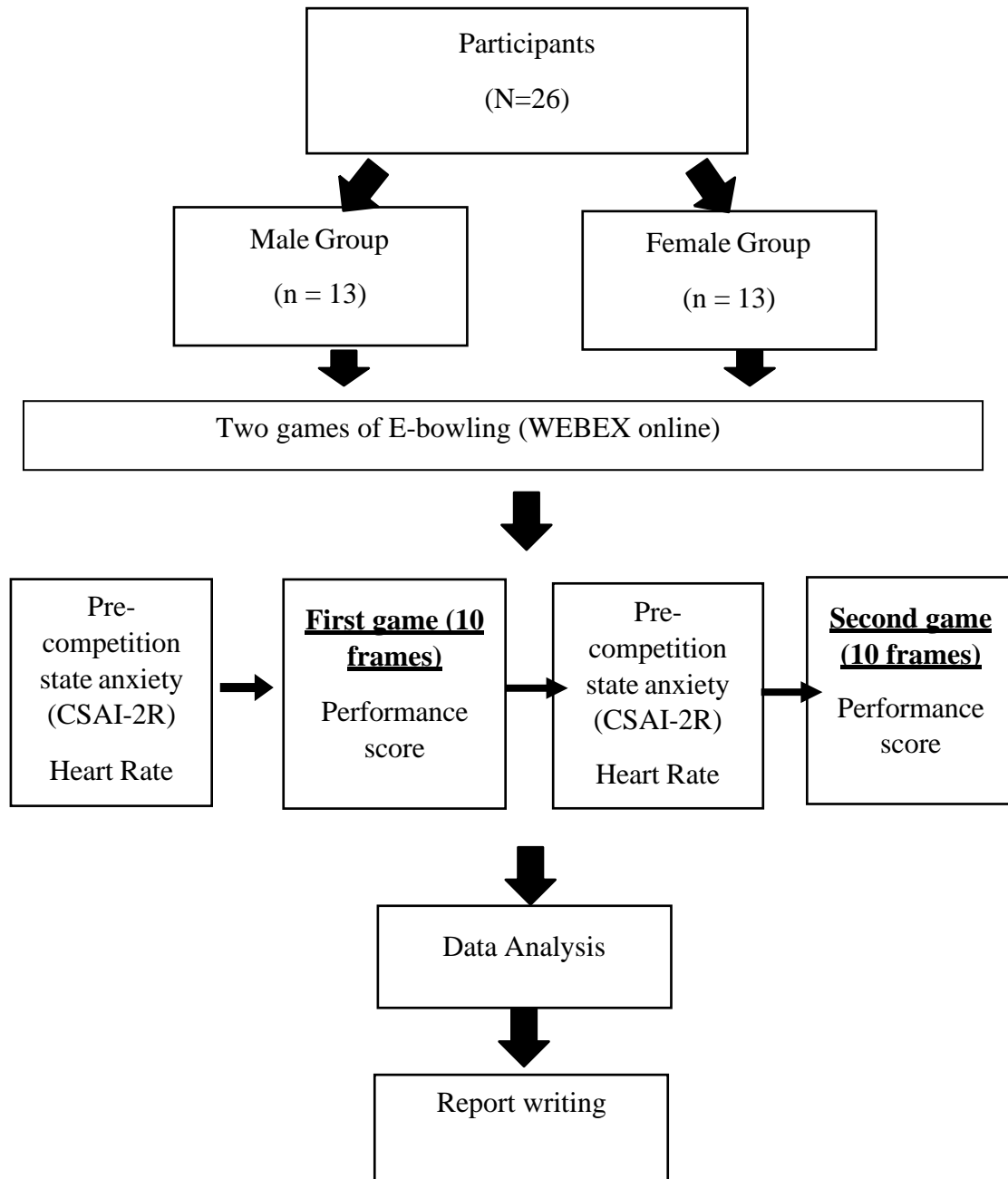
Figure 1: Flow chart of the study

Statistical analysis

All data were reported in mean and standard deviation. IBM StatisticalPackage for Social Sciences (SPSS) version 27 was used to analyze the data. First, the data was checked for normality. After conforming the normality, an independent-t-test was used to seek the differences for the state anxiety, heart rate, and performance between male and female groups. The level of significance was set at $p < .05$.

Somatic State Anxiety

Table 4.1 shows the mean and standard deviation of somatic state anxiety formale and female groups. The data indicates the somatic state anxiety is significantlyhigher ($p = .025$) in female group as compared to male group.

Table 4.1

Somatic State Anxiety in Male and Female Groups

Variable	Male Group		Female Group		*p*-value
	n	Mean ± SD	n	Mean ± SD	
Somatic state anxiety	13	16.87 ± 3.86	13	21.42 ± 5.67	.025

Significant difference at $p < 0.05$

Cognitive State Anxiety

Table 4.2 shows the cognitive state anxiety for male and female groups. The data indicates the somatic state anxiety is not significantly difference ($p = .634$) between male and female groups.

Table 4.2

Cognitive State Anxiety in Male and Female Groups

Variable	Male Group		Female Group		p-value
	n	**Mean ± SD**	**n**	**Mean ± SD**	
Cognitive state anxiety	13	21.28 ± 5.38	13	22.31 ± 5.53	.634

Significant difference at $p < 0.05$

Pre-competitive Heart Rate

Table 4.3 shows the pre-competitive heart rate for male and female groups.The data indicates the pre-competitive heart rate is not significantly difference ($p = .256$) between male and female groups

Table 4.3

Pre-competitive Heart Rate in Male and Female Groups

Variable	Male group		Female group		*p*-value
	n	**Mean ± SD**	**n**	**Mean ± SD**	
Heart rate (bpm)	13	79.00 ± 0.91	13	83.15 ± 6.84	0.256

Significant difference at $p < 0.05$

Performance of E-bowling game

Table 4.4 shows the performance of E-bowling game for male and female groups. The data indicates the performance of E-bowling game is not significantly difference ($p = .945$) between male and female groups.

Table 4.4

Performance of E-bowling game in male and female groups

Variable	Male Group		Female Group		p-value
	n	**Mean ± SD**	**n**	**Mean ± SD**	
E-bowling performance (score)	13	118.69 ± 25.75	13	119.31 ± 8.60	0.945

Significant difference at $p < 0.05$

CHAPTER 5

DISCUSSION

Overall, the present study found that when comparing between male and female groups, the somatic state anxiety was significantly higher in female group andother variables including cognitive state anxiety, pre-competitive heart rate, and E- bowling performance showed no statistically differences.

The present study showed that there was a significant difference in somatic state anxiety in male and female individuals playing e-bowling. Previous studies demonstrated that females reported higher level of somatic state anxiety as compared to males in competition situations. For example, Parnabas (2020) stated in his study that the level of somatic state anxiety of female athletes was higher (17.39) than males(13.71). In addition, Farooq et al. (2014) reported that female collegiate athletes hadsignificantly higher mean somatic state anxiety (19.9) compared to male collegiate athletes (18.2) before a game of volley ball, basketball, hand ball and individual sports, table tennis (single), badminton (single) and athletics. An interventional study conducted by Lim et al (2011) among Malaysian volleyball players also found that the somatic state anxiety of the male players (15.34 ± 2.41) was lower than the femaleplayers (17.07 ±.59) after receiving a psychological intervention to manage their cognitive anxiety. On the other hand, female athletes showed a gradual increase in somatic anxiety as competition neared (Jones, Swain & Cale,1991). thus suggested the influence of different genders on state anxiety changes. These findings suggested female and male athletes might response differently in terms of their somatic state anxiety regulation during competitive situations.