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Effect of Word Choice on Comfort Level in Male Collegiate Hockey Players during Air Displacement Plethysmography Assessments

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INTRODUCTION

Research has demonstrated a positive correlation between nutrition and sport performance, through enhanced physical performance and decreases recovery time (Torres-McGehee et al., 2012). Body composition assessments, an important component of sports nutrition, allows trainers, coaches, and athletes to track body composition changes in attempts to improve performance (Ackland et al., 2012; Prokop, Reid & Andersen, 2015; Torres-McGehee et al., 2012). Body composition is most commonly assessed through skin-folds, Bioelectrical Impedance Analysis, Underwater Weighing, Dual-energy X-ray Absorptiometry, and Air Displacement Plethysmography (BOD POD). However, research has shown that the BOD POD is among the most accurate and least invasive body composition assessment methods, with an average test-retest variation of 2% (McArdle, Katch & Katch, 2000).

Specifically, in male hockey players, research has shown that an increase in body mass may improve overall performance and reduce injury risk (Houde et al., 2017; Montgomery, 2006; Potteiger et al., 2010), however added weight has shown to negatively impact skating performance (Montgomery, 1982). As lean body mass increases, the body's protective barrier is strengthened, reducing risk for injury (Hagmar et al., 2013; Houde et al., 2017, Montgomery, 2006). Increases in lean body mass may also improve skating ability and power generation, skills necessary for high performance in hockey, by limiting frictional resistance (Potteiger et al., 2010; Prokop, Reid & Andersen, 2015; Montgomery, 1988; Quinney et al., 2008).

Although an athlete's body composition data serves as a useful tool to improve overall performance, all body composition assessment methods are subject to error. Results from the BOD POD are subject to the average test-retest variation of 2% (McArdle, Katch & Katch, 2000).

Due to error in assessment methods, the results may not reflect the athlete's true body composition values such as body fat percentage or lean body mass. For the BOD POD, improper testing attire has been shown to result in higher estimations of body fat percentage due to air trapped within the hair on the scalp (Peeters & Claessens, 2010). Unlike other assessment methods, the BOD POD requires the athlete to participate when the measured thoracic gas volume (TGV) is taken. Depending on the participant, the measured TGV may not be within the acceptable range. Changes in breathing patterns have been shown to alter the measured TGV value (Tegenkamp et al., 2011). Both high and low measured TGV estimations result in an overestimation of body fat percentage (Tegenkamp et al., 2011). Obtaining a measured TGV within the acceptable range of +/- 100 mL from the predicted TGV is crucial to receiving the most accurate body composition results (COSMED, 2016). Anxiety throughout the BOD POD assessment could result in increased depth and rate of breathing that impact the TGV measurement, resulting in changes of estimated body composition (Tipton et al., 2017).

Anxiety in athletes can decrease performance and increase risk of injury (Englert & Bertrams, 2012; Hwang & Choi, 2016; Li et al., 2017). Performance requires selective attention or the ability to focus on a task and block out distracting stimuli (Schmeichel & Baumeister, 2010). However, anxiety disrupts the athlete's ability to maintain selective attention (Englert & Bertams, 2012), impairing their "performance" or their ability to follow the verbal instructions given on the BOD POD and TGV procedures. Triggers of anxiety include threatening and evaluative situations (Englert & Bertams, 2012). The evaluative aspects of BOD POD assessments may be falsely seen as a performance test, triggering performance anxiety in participants. The results of the BOD POD are values that hold the same standard in athletes' minds as sprint times or maxes for weight lifting. The results seem to evaluate an athlete's diet or training regime.

Although research has not looked at the impact of word choice on athletes' anxiety levels, words that imply evaluative results could raise anxiety levels, causing increased depth and rate of breathing. The word "test" was chosen for the experimental group instructions because "test" implies the assessment is evaluative. The word "measure" was chosen for the control group because "measure" has less of an evaluative connotation by definition. It was hypothesized that subjects who received verbal instructions containing "test" would self-report lower comfort levels for the BOD POD and TGV procedures. This research hopes to help determine the impact to which word choice during verbal instructions influences comfort level of athletes during the BOD POD, in an effort to increase the accuracy in body composition measurements.

METHODS

The sports dietitian and athletic department identified the male collegiate teams that would undergo testing in the BOD POD. The sports dietitian and the undergraduate research assistants identified multiple time blocks for team testing and participants signed up based on their availability. Assessment days were predetermined and athletes were randomized into the control or experimental group based on their self-selected assessment date.

Prior to the start of all assessments, the BOD POD and BOD POD scale were calibrated according to manufacturer's protocol (COSMED, 2016). The BOD POD scale was calibrated using a known weight (20.0 kg). The BOD POD was calibrated using a cylinder of a known volume (50.159 L). Upon arriving at the Nutrition Assessment Laboratory, the participant was given a consent form by the research assistants. The consent form provided the research assistants permission to use previous and current BOD POD data for research purposes. If consent was not received, the results were not included in data analysis for research purposes.

The participant was provided a separate, private area of the lab to change into appropriate testing attire including tight fitting spandex and a swim cap. The participant was then instructed to enter the area of the lab containing the BOD POD. Before each test, the research assistant calibrated the BOD POD using the known weight (20.0 kg) and the cylinder of a known volume in accordance with the BOD POD manual (50.159 L) (COSMED, 2016). During the calibration phase, the participant's height (in.), weight (lbs.), and waist circumference (in.) were measured. Once the calibration was complete, the participant was instructed to put on a swim cap and enter the BOD POD. The research assistant instructed the participant on the general procedure of the BOD POD in accordance with the BOD POD manual (COSMED, 2016). The participant was instructed to breath normally, remain relaxed, and sit still throughout the two, one-minute tests. Upon completion of the two body volume measurements, the research assistant instructed the participant on the thoracic gas volume (TGV) procedure in accordance with the BOD POD manual (COSMED, 2016). This procedure served as the basis for the intervention of the present study. Participants in the control group (n=13) were instructed on the BOD POD and TGV procedure with verbal instructions containing the word "measure." The experimental group (n=15) was instructed verbally on both procedures with dialogue only containing the word "test."

Once a TGV within the acceptable range was obtained, the participant exited the BOD POD and changed back into normal attire. All athletes were asked two questions pertaining to their comfort level with the BOD POD procedure and the TGV portion of the body composition testing. Athletes self-reported their comfort level during both procedures on a scale from 1 to 5, 1 being the least comfortable and 5 being the most comfortable. Differences between the BOD POD comfort levels and the TGV comfort levels of the control and experimental group were used to determine if word choice had an impact on the comfort levels of the athletes.

At baseline assessments, the intervention of the present study was implemented. At follow-up assessments, all participants were instructed using the same verbal instructions for follow-up testing. Participants in the control and experimental groups were mixed because the athletes self-selected their test date. All anthropometric measurements and body composition data were recorded under an encoded number (AT00##). For data analysis purposes, the follow-up assessment results of the participants were organized based on their baseline grouping assignments, control and experimental.

RESULTS

Participant Characteristics

A total of 28 male division I collegiate hockey players participated in the study. Participants self-selected one of two pre-determined assessment dates. Thirteen of the athletes (46.4%) were in the control group, as defined by the use of the word 'measure' when instructing the athlete on how to complete the thoracic gas volume (TGV) component of the BOD POD. Fifteen of the athletes (53.6%) were in the experimental group, as defined by the use of the word 'test' when instructing the athlete on how to complete the TGV component of the BOD POD. At baseline and follow-up, the average body composition and anthropometric measurements for both groups were relatively similar (Table 1). The average predicted body fat percentage of all the participants (11.8%) and the average measured body fat percentage (12.2%) was higher than the average body fat percentage (8.64%) of the elite NCAA Division 1 men's ice hockey players (Runner et al., 2016).

TABLE 1
Means of body composition and anthropometric measurements of control and experimental groups at baseline and follow-up

Body Composition	Control (n=13)		Experimental (n=15)	
	Baseline (n=13)	Follow-Up (n=12)	Baseline (n=15)	Follow-Up (n=12)
HT (in)	71.95	71.95	71.36	71.36
WT (lbs)	192.06	189.43	184.19	187.99
WC (in)	33.77	33.98	33.77	34.4
MTGV (L)	4.464	4.405	4.204	4.089
M FAT %	11.21	13.06	13.13	15.6
PTGV (L)	4.215	4.111	4.052	4.011
P FAT %	10.0	12.84	13.4	16.45

M stands for measured and P stands for predicted.

Statistical Analysis

The data were analyzed using SPSS (Version 24) to evaluate differences between the comfort levels of the control and the experimental groups at baseline, differences between comfort levels within all participants from baseline to follow-up, and differences in comfort level within the control and experimental groups from baseline to follow-up. The differences between the TGV comfort level and BOD POD comfort level of the control and the experimental groups were analyzed using an independent samples t-test. Lasting effects of word choice were analyzed using frequencies and a linear regression. Differences in means and frequencies of responses for TGV and BOD POD comfort level were calculated to analyze the impact of factors besides word choice on the participants comfort level.

Differences Between Control and Experimental Groups at Baseline

The mean BOD POD comfort level for the control was 4.33 (SD= 0.98). For the experimental group, the mean BOD POD comfort level was 4.46 (SD= 0.78). The differences in the mean BOD POD comfort level of the control and experimental groups at baseline were not statistically significant *(t = 0.380, p = 0.707).*

The mean TGV comfort level for the control group was 3.8 (SD= 1.474). The mean TGV comfort level for the experimental group was 4.15 (SD= 0.8). There was no significant difference between the mean TGV comfort level of the control group and experimental group at baseline *(t = 0.803, p= 0.430).*

Differences Between Control and Experimental Groups at Follow-Up

At follow-up, the mean BOD POD comfort level for the control group was 4.67 (SD= 0.65) and the mean comfort level for the experimental group was 4.5 (SD= 0.67). There was no significant difference between the BOD POD comfort level of the control group and experimental group at follow-up (*t = -0.616, p = 0.544).*

The mean TGV comfort level for the control group was 4.5 (SD= 0.67) and the mean comfort level for the experimental group was 3.64 (SD= 1.36). The differences between the TGV comfort level of the control and experimental groups at follow-up were not significant (*t = -1.901, p = 0.078).*

Comparison Within Control Group and Experimental Group Between Baseline and Follow-Up

In the control group, BOD POD comfort level at baseline was not a predictor for follow-up BOD POD comfort level (R^2=0.223, p=0.121). In the experimental group, baseline BOD POD comfort level was a predictor for follow-up BOD POD comfort level (R^2=0.354, p=0.041).

TABLE 2

Frequencies of self-reported comfort level of control and experimental groups with BOD POD procedure at baseline and at follow-Up

Frequencies	**Control (n=13)**		**Experimental (n=15)**	
	Baseline (n=13) μ= 4.46	**Follow-Up (n=12) μ = 4.5**	**Baseline (n=15) μ = 4.33**	**Follow-Up (n=12) μ = 4.67**
1	0	0	0	0
2	0	0	0	0
3	2	1	5	1
4	3	4	0	2
5	8	7	10	9

In the control group, TGV comfort level at baseline was a predictor for TGV comfort level at follow-up (R^2=0.348, p= 0.043). In the experimental group, TGV comfort level for baseline was not a predictor for TGV comfort level at follow-up (R^2=0.133, p=0.270).

Table 3

Frequencies of self-reported comfort level of control and experimental groups with TGV procedure during baseline and follow-Up

Frequencies	**Control (n=13)**		**Experimental (n=15)**	
	Baseline (n=13) μ = 4.15	**Follow-Up (n=11) μ = 3.64**	**Baseline (n=15) μ = 3.8**	**Follow-Up (n=12) μ = 4.5**
1	0	1	1	0
2	0	1	3	0
3	3	3	2	1
4	5	2	1	4
5	5	4	8	7

Results examining the frequencies of responses for all participants at baseline and follow-up are detailed in table 4 and table 5.

Table 4

Frequencies of self-reported comfort level of all participants with BOD POD procedure during baseline and follow-up

Frequencies	**Baseline (n=28) μ = 4.39**	**Follow-Up (n=24) μ = 4.58**
1	0	1
2	0	1
3	3	3
4	5	2
5	5	4

Table 5
Frequencies of self-report comfort level of all participants with TGV procedure during baseline and follow-up

Frequencies	**Baseline (n=28) μ = 3.96**	**Follow-Up (n=23) μ = 4.09**
1	1	1
2	3	1
3	5	4
4	6	6
5	13	11

DISCUSSION

The BOD POD has become a widely used assessment tool to measure body composition of athletes due to the low standard of error and quick assessment methods (McArdle, Katch & Katch, 2000). Although this assessment method is frequently utilized by sports dietitians and strength coaches, the impact and potential emotional ramifications of word choice utilized in the verbal instructions of the procedure is not understood. Englert and Bertrams (2012) and Schmeichel and Baumeister (2010) found that that anxiety, a common emotional response, decreases athletic performance by disrupting the ability to maintain selective attention.

Performance could be described as an athlete's ability to follow verbal instructions during the BOD POD and thoracic gas volume (TGV) procedures. Anxiety could disrupt the athlete's ability to maintain a relaxed, normal breathing rate. Homma and Masaoka (2008) have demonstrated that as anxiety increases, the rate of breaths per minute increases. An incorrect estimation of measured thoracic gas volume (TGV) results in an incorrect estimation of body fat percentage. It is important to understand the sources of anxiety during the BOD POD procedure to increase the likelihood of achieving an accurate measurement of body composition (Tipton et al., 2017; Tegenkamp et al., 2011).

It was hypothesized that the usage of the word “test” in the verbal instructions given to the participant would decrease their comfort level during both the BOD POD and TGV procedures. Based on the results of the present study, the hypothesis was partially supported. There was no significant difference between the comfort level of the control group or the experimental group between baseline and follow-up, suggesting that “measure” and “test” can be used interchangeably within the verbal instructions for the BOD POD and TGV procedures without having impact on comfort level.

Although the differences in means between the control and experimental groups were insignificant, the frequency of self-reported responses had different distributions. The control group at baseline had a greater number of participants report a comfort level of a 4 or a 5 during both procedures than the experimental group. However, the distributions of frequencies of responses for follow-up shifted. The experimental group had a greater number of participants report a comfort level of 4 or 5 with both procedures, implying a factor beside word choice such as confidence level of perception of the BOD POD is affecting the comfort level of participants.

Multiple research studies looking at the relationship between anthropometric measurements and performance of male collegiate hockey players have been conducted (Peyer et al., 2011; Potteiger et al., 2010; Prokop, Reid & Anderson, 2015). To our knowledge, no current research has looked at the impact of specific word usage on comfort levels of athlete’s during specific tasks or the relationship between their comfort levels on performance during body composition assessments that requires the athletes to participate, such as the BOD POD or Underwater Weighing.

However, current research that looks at the use of verbal instructions to focus attention externally on a task may explain the lack of significant differences between the control and the experimental groups of the present study. Multiple studies have shown that verbal instructions that promote an external focus of attention resulted in improved athletic performance when compared to the performance of participants that focused attention internally (Porter et al., 2010; Wu et al., 2012). Porter and collaborators (2010) found that participants who focused on the floor, cones, or a combination of both performed faster on agility tests than participants who focused on their own body movements. A 2012 study found similar results for the standing long jump (Wu et. al). Participants that were instructed to focus on reaching the cone, an external focal point, jumped a significantly farther distance than participants who were instructed to focus on the mechanics of the jump (Wu et al., 2012).

While the studies by Porter and collaborators (2010) and Wu and collaborators (2012) measured athletic performance through results of a specific task, the overall findings of the results may explain why there was no significant difference between the control and experimental groups for the present study. Athletes perform better if their attention is focused externally than if they receive neutral verbal instructions or focus externally (Porter et al., 2010; Wu et al., 2012). The words used in the verbal instructions for the BOD POD, “measure” and “test”, may shift the athlete’s focus internally. The athlete may be more focused on their own internal anxiety from the results of the assessment or outside stressors, taking attention away from focusing on following the verbal instructions given for the TGV and BOD POD procedure.

However, since alterations in word choice showed no significant difference, the verbal instructions as a whole may be shifting the athlete’s focus internally. The instructions often emphasize remaining still and breathing at a normal rate, regardless of the component of the assessment being performed. If verbal instructions included points that emphasized focuses on the wall or focusing on following the rate of breathing set by the computer for the TGV measurement, their attention may shift externally and improve their performance during the BOD POD assessments. Future research could alter the focal point emphasized in the verbal instructions to compare the impact of external focus and internal focus on comfort levels.

Confidence level of the participant may have also contributed to the lack of significant results in the present study. Woodman and Hardy (2003) found that individuals with higher self-confidence had significantly increased athletic performance and individuals with lower cognitive anxiety had significantly decreased athletic performance. However, self-confidence had a significantly stronger correlation with athletic performance than anxiety (Woodman). In the terms of the BOD POD, it is reasonable to assume that athletes with a higher self-confidence feel more comfortable with the BOD POD and TGV procedures than athletes with lower self-confidence. Their higher self-confidence may result in a lowered overall anxiety state about the BOD POD assessments. These athletes may be able to maintain selective attention and a relaxed breathing rate, resulting in better performance on the TGV measurements.

Because participants selected a predetermined test date, there could have been an equal distribution of confidence levels within the control and experimental groups. Since confidence levels have shown a stronger impact on performance than anxiety, an equal distribution of confidence levels could have resulted in the significant results. The present study did not measure self-confidence of the participants. Future research could examine the relationship between self-confidence levels and performance in the BOD POD.

The limitations of the present study highlight the need for continued research. The total sample size was small and in future research, larger populations should be used. The participants also had previous exposure to the research assistant. The participants may have felt more comfortable because they knew the research assistant. Comfort level was measured using a self-reported value on a scale of 1 to 5. Participants may have incorrectly reported comfort levels due to an effort to please the research assistant, fear of being judged for their response, misunderstanding of the scale, or perceived performance on the assessments. Participants who had lower body composition numbers or completed the TGV measurement may have felt more comfortable because they performed “well” in the BOD POD.

In conclusion, the present study did not find any significant results pertaining to the impact of word choice on comfort level in the BOD POD. The results suggest that “measure” and “test” can be used interchangeably throughout BOD POD assessments and have no impact on the participant’s comfort levels. The present study also draws attention to the fact that all athletes are very different individuals. Researchers, strength coaches, sports dietitians, and anyone using the BOD POD should adjust their verbal instructions based on the athlete being assessed.

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