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ACCURACY OF SELF-REPORTED HEIGHT, BODY MASS AND DERIVED BODY MASS INDEX IN A GROUP OF UNITED STATES LAW ENFORCEMENT OFFICERS

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Abstract: Height and body mass data is often self-reported by study participants. However, the accuracy of self-reported height and body mass data compared to these same measures collected by researchers is unknown. The purpose of this study was to compare the accuracy of self-reported height and body mass data to measured values within the US law enforcement population, and the impact these estimations have on the accuracy of BMI classifications. **METHODS:** Self-reported and measured height and body mass data for thirty-three ($n = 33$) male law enforcement officers (age: 40.48 ± 6.66 yrs; measured height: 180.42 ± 6.87 cm; measured body mass: 100.82 ± 19.86 kg) were utilized for this analysis. **RESULTS:** Paired samples t-tests revealed no significant differences in estimated and measured height ($p=.830$), body mass ($p = .527$) or BMI ($p = .623$). **CONCLUSION:** Self-reported height and body mass was accurate for calculating BMI within this population sample.

Keywords: anthropometrics; health assessment; police; obesity.

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Introduction

The duties of a police officer vary dramatically in terms of physical demands (Davis, Easter, Carlock, Weiss, Longo, Smith, Dawes, & Schilling, 2016; Dawes, Lindsay, Bero, Elder, Kornhauser, & Holmes, 2017; Stommel & Schoenborn, 2009). As part of their normal job duties an officer may be expected to transition from relatively sedentary behavior, such as sitting in a vehicle or talking to civilians, to sudden bouts of maximal effort activity with little warning (Dawes, et al., 2017; Orr, Dawes, Pope, & Terry, 2017). For those officers that are overweight or obese this can create a significant strain on their musculoskeletal and cardiovascular system, thereby, increasing their risk of experiencing an injury, task failure or encountering a life-threatening (i.e. cardiovascular incident) situation (Dawes, Kornhauser, Crespo, Elder, Lindsay, & Holmes, 2018; Dawes, Orr, Elder, & Rockwell, 2014; Després, 2012; Gu, Burchfiel, Fekedulegn, Sarkisian, Andrew, Ma, & Violanti, 2012; Holliday, Williams, Maciewicz, Muir, Zhang, & Doherty, 2011). For these reasons, assessing an officer's health risk should be one of the primary concerns for police agencies.

Body Mass Index (BMI) is a frequent method of assessing individual health status and for predicting morbidity and mortality risk (Pasco, Holloway, Dobbins, Kotowicz, Williams, & Brennan, 2014). BMI can be calculated by dividing body mass in kilograms (kg) by height in meters squared (m^2) (Stommel, & Schoenborn, 2009). Based on their BMI score an individual may be classified into one of six major categories: underweight ($BMI < 18.5 \text{ kg}/m^2$), normal weight ($18.5 < 25 \text{ kg}/m^2$), overweight ($25 < 30 \text{ kg}/m^2$), low obesity ($30 < 35 \text{ kg}/m^2$), medium obesity ($35 < 40 \text{ kg}/m^2$), and extreme obesity ($\geq 40 \text{ kg}/m^2$) (National Institutes of Health, 1998). Individuals with a BMI over $25 \text{ kg}/m^2$ are considered at greater risk for disease and certain medical complications, such as heart disease, hypertension, type 2 diabetes, gallstones, breathing problems, and some types of cancers (National Institutes of Health 1998). Although BMI has been criticized as being inaccurate for individuals with larger body frames and greater muscle mass (Charles, Burchfiel, Violanti, Fekedulegn, Slaven, Browne, Hartley, & Andrew, 2008; Stommel & Schoenborn, 2009), it does provide an easy and cost effective health risk assessment that can be used to broadly determine if more invasive measures of body composition are warranted (Stommel & Schoenborn, 2009).

Previous investigations have explored the validity of self-reported height, body mass, and BMI (Martin, Grier, Canham-Chervak, Anderson, Bushman, Degroot, & Jones, 2016; Nyholm, Gullberg, Merlo, Lundqvist-Persson, Råstam, & Lindblad, 2007; Wen, & Kowaleski-Jones, 2012). For instance, Nyholm et al. (2017) investigated self-reported height, body mass, and corresponding BMI compared to measured data for 1703 participants between the ages of 30-75 years from a community of individuals living in Sweden. Both sexes self-reported greater average height measurements ($\sim 0.3 \text{ cm}$ among males; $\sim 0.4 \text{ cm}$ among females) when compared to measured values. Additionally, Nyholm et al. (2017) discovered that self-reported body mass differed on average by 1.6 kg less than the measured values among males, and 1.8 kg less than the measured values amongst females. Wen and Kowaleski-Jones (2012) also found that adult subjects tended to over-report height and under-report body mass. These authors reported that factors such as sex, overweight and obesity



classifications, age, and level of education might influence reporting accuracy. Similarly, Martin et al. (2016) investigated the accuracy of self-reported BMI among 1047 male and female soldiers. These researchers discovered that both sexes tended to overestimate height, which resulted in the underestimation of BMI. These data have implications in populations that utilize the self-reporting of height and body mass, and also have serious health considerations. One example of this is in law enforcement officers (LEOs).

Several research studies have used self-reported height and/or body mass data among law enforcement officers (LEOs) (Dawes et al., 2017; Lockie, Dawes, Kornhauser, & Holmes, 2019). This often occurs in law enforcement agencies (LEAs) due to a lack of time and/or equipment. An example of a situation where this would occur is during the hiring process, where certain agencies hold accelerated hiring opportunities, where individuals can complete several of the steps required in the hiring process. This allows for large numbers of individuals to be processed within a short time frame; however, the accurate measurement of height and body mass may be deprioritized. This could be problematic, as some positions in a LEA can have height and body mass as part of their hiring requirements, without any subsequent fitness testing (e.g. custody assistants) (Lockie et al., 2018; Los Angeles County Sheriffs, 2017). However, there is no current information regarding the accuracy of self-reported height, BM and corresponding BMI calculations in a LEO population.

Thus, the purpose of this study was to compare the accuracy of self-reported height and body mass data to measured values within a law enforcement population, as well as to compare BMI classification between these two conditions. The researchers hypothesized that the measurements obtained via self-reported methods in this population would be statistically different from those measured using a standard scale and stadiometer. In-line with previous research, it was hypothesized that height would be over-estimated and body mass underestimated. Further, it was hypothesized that significant differences in BMI classifications would be discovered within this population based on self-report compared to measured data.

METHODS

Experimental Approach to the Problem

Self-reported height and body mass data were collected from LEOs belonging to a US LEA prior to mandatory marksmanship training. Immediately after self-report data were collected, LEOs were informed of the study being conducted and were asked to sign an informed consent allowing the investigators to utilize their previously reported height and body mass data, as well as allowing the members of the training staff to measure their actual height and body mass using a stadiometer and electronic scale. This data were then provided to the primary investigator for analysis.



Subjects

Self-reported and measured height and body mass data for thirty-three ($n = 33$) male LEOs (age: 40.48 ± 6.66 yrs; BH: 180.42 ± 6.87 cm; BM: 100.82 ± 19.86 kg) were collected and utilized for this analysis. After providing self-reported data, officers were provided with an informed consent requesting to utilize this data along with measured height and body mass data to calculate the officers' corresponding BMI under each condition (i.e., self-report vs. measured height and body mass). The LEOs were not aware that this information may be used for analysis at the time they self-reported. None of the LEOs involved in the training declined the invitation to participate in this research study. Prior to collection of this data, approval to analyze this information was obtained from the University of Colorado, Colorado Springs Institutional Review Board (IRB 16-041) for human subjects.

Procedures

All self-reported and measured height and body mass measurements were collected indoors at the LEA's training facility. The protocols for collection of these measurements is detailed hereafter.

Self-reported age, body height and body mass: Age (years), height (in) and body mass (lbs) measurements for LEOs were self-reported on a standard data sheet provided to each of them by the training staff prior to training. All imperial measures such as inch (in) and pounds (lbs) were converted to metric values for analysis.

Measured height and body mass: Body height (BH) (cm) and body mass (BM) (kg) were measured shoeless, using a portable stadiometer (Seca®, California, USA) and a digital electronic scale (Health-O-Meter®, McCook, IL, USA).

BMI calculation and classification: BMI was calculated during analysis after converting the measurements of height and body mass into the appropriate units. BMI was derived using the equation $BMI = \text{body mass (kg)} / [\text{height (m)}]^2$ (Dawes et al, 2018; Nyholm et al., 2007). Once calculated, BMI was then used to group officers based on risk stratification (National Institute of Health, 1998) (Table I).

Table I: Classification according to the National Institutes of Health, 1998

Nutritional status	BMI values
Underweight	$< 18.5 \text{ kg/m}^2$
Normal	$18.5 - 24.9 \text{ kg/m}^2$
Overweight	$25.0 - 29.9 \text{ kg/m}^2$
Obesity I	$30.0 - 34.9 \text{ kg/m}^2$
Obesity II	$35.0 - 39.9 \text{ kg/m}^2$
Obesity III – Extreme obesity	$> 40.0 \text{ kg/m}^2$



Statistical Analysis

Collected data were entered into a computer file suitable for statistical analysis using the Statistics Package for Social Sciences (SPSS) (Version 25.0; IBM Corporation, New York, USA). A descriptive statistical analysis was conducted to determine the mean values and standard deviations for the total sample and on all collected data. Comparisons between self-reported and measured values for each of the variables were conducted using a series of paired samples t-tests with alpha levels set at 0.05 a priori.

Results

The descriptive data and comparisons between estimated and measured anthropometrics for this sample are presented in Table II. The results of the paired samples t-tests revealed no significant differences in estimated and measured height, estimated and measured body mass or in BMI based on the estimated or measured values (Table III). Although statistically insignificant, differences did exist in some of the self-reported data. However, none of these errors resulted in any BMI category misclassifications. Further, when separately evaluating BMI data, it was found that 9% (3/33) of the officers in this study were at “Normal” body mass, 49% (16/33) were classified as “Overweight”, 18% (6/33) were classified as “Obesity Class I”, 21% (7/33) were classified as “Obesity Class II”, 3% (1/33) would be in the “Obesity Class III” category.

Table II: Descriptive Data and Comparisons

Variable	Self-Reported Mean \pm SD (range)	Measured Mean \pm SD (range)	Differences Mean \pm SD (range)
Ht (cm)	180.49 \pm 6.62 (165.10-195.58)	180.42 \pm 6.87 (165.61-200.66)	0.08 \pm 0.25 (-5.08-4.83)
BM (kg)	100.59 \pm 19.54 (71.82-154.55)	100.82 \pm 19.86 (71.09-156.27)	-0.23 \pm 0.32 (-7.36-3.64)
Estimated BMI	30.69 \pm 4.94 (23.30-42.02)	30.76 \pm 4.88 (23.43-41.50)	-0.07 \pm 0.86 (-2.06-2.15)

* Significant difference at $p \leq 0.05$

Table III: Paired Samples T-Test

			t	df	p
BM	-	Self-reported BM	0.639	32	0.527
HT	-	Self-reported HT	-0.217	32	0.830
BMI	-	Estimated BMI	0.497	32	0.623

* = Significance at the $p \leq .05$



Discussion

The purpose of this investigation was to compare the accuracy of self-reported height and body mass data to measured values among a population of LEOs, and determine if correct BMI classifications could be determined using self-report data. The results of this study suggested that self-reported body height and body mass information in this - US based LEO population was accurate, and correct BMI classifications could be determined using this data. This is the first study to investigate the accuracy of self-reported anthropometric data in the US law enforcement population. Based on these findings the researchers rejected the hypothesis that self-reported height and body mass data would be significantly different from measured values and that differences in this data would lead to BMI misclassifications. The results from this study have important implications for strength and conditioning coaches and training staff that are responsible for developing health and wellness interventions for LEOs, and for researchers and other health professionals who, due to time constraints or accessibility, often must rely on self-reported height and body mass measures. This research supports that self-reported anthropometric data may be used as an easy and cost-effective tool for determining the height, body mass and, as such, BMI in this population.

Previous research indicates that information related to self-reported height tends to be over-reported (greater) among those in the general population (Bowring, Peeters, Freak-Poli, Lim, Gouillou, & Hellar, 2012; Nyholm et al., 2007; Wen, & Kowaleski-Jones, 2012; Martin et al., 2016). Among the sample of officers in this study it was observed that the mean self-reported height did not significantly differ from measured height. In fact, the average difference between estimated and actual height was only 0.07 ± 2.03 cm. It was also discovered that 14 of the officers overestimated height, 15 underestimated their height, and 4 were exact in their estimation. This may have been because officers only provided height estimates using whole numbers and may have simply rounded to the nearest $\frac{1}{2}$ inch (1.27 cm). The precision of these estimations may have also been due to officers being familiar with these anthropometric measures due to workplace health intervention programs/requirements, and the constant need to provide these values (e.g. for sizing during equipment issue). Although the sample was drawn from one agency, this study provides some support to agencies that are reliant on their officers or candidates to self-report height during their employment or in the hiring process (Los Angeles County Sheriff's Department, 2017; Lockie et al., 2018).

Several studies have noted that self-reported body mass data tend to be under-reported (lower) within general populations (Bowring et al., 2012; Nyholm et al., 2007; Wen, & Kowaleski-Jones, 2012). In contrast, in this sample of LEOs the mean self-reported body mass did not significantly differ from measured body mass. Similar to Bowring et al. (2012), the differences in self-reported and measured body mass tended to be greater compared to height. However, this may be due to the propensity for body mass to fluctuate based on time of day, hydration and nutritional status when compared to height (which should be stable) (Buckler, 1978). Nonetheless, the officer's self-reported body mass only differed -0.23 ± 2.03 kg on average



from measured BM mass. It was discovered that 12 officers underreported their body mass, 13 over reported their body mass and 6 officers were within 0.45 kg of actual body mass. However, none of these estimations resulted in a misclassification of BMI for the officers in this study. On this basis, when there are no consequences associated with the level of body mass, estimations of body mass can be considered as being relatively accurate within this population and may not impact estimated BMI from self-reported data.

Self-reported height and body mass data have been used in previous research to estimate BMI and overall health status (Bowring et al., 2012, Nyholm et al., 2007; Wen, & Kowaleski-Jones, 2012; Martin et al., 2016). The misreporting or misrepresentation of this self-reported data can lead to inaccurate estimations and misclassifications of an individual's health risk. In this study 97% of the officers were classified correctly according to the National Institute of Health's BMI classification scale using self-reported data. The only officer misclassified underreported their BM (by 1.73 kg), and height (by 5.08 cm), which led to a misclassification of their health status as "Obesity Class II" when the accurate classification was actually "Obesity Class III". Thus, it appears that within this population that self-reported height and body mass can be used to accurately determine epidemiological information (i.e., general health risk or status).

A notable limitation of this study was the lack of female participants. As such, potential sex-based differences in self-reporting these measures may exist. However, whilst Wen and Kowaleski-Jones (2012) suggest that sex may influence self-report accuracy in these measures, potential sex differences may not be significantly different between populations with both males and females found to slightly under report body mass and over report height to a similar extent (Nyholm et al., 2017). Nonetheless, future research on self-reported height and body mass should incorporate female subjects. Additionally, the median age in this study was 40.48 ± 6.66 yrs. Future research, should investigate whether differences exist based on age range. This study also included a small sample of LEOs from one agency. The data shown may not be representative of all LEOs.

Conclusion

The results of this study suggest that male LEOs accurately self-reported their height and body mass relatively to their measured data. Additionally, when using a broad BMI classification scale, self-reported height and body mass can be used to accurately determine BMI classification group. When the ability to objectively measure height and body mass is not viable for law enforcement agency staff, self-reported data can be used as a surrogate. However, if any of the data indicates a health risk (i.e. BMI > 25), or if height and body mass directly relates to occupational tasks, it is recommended that staff use more accurate methods to measure height, body mass, and BMI.



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