Int. J. Morphol.,
42(6):1686-1693, 2024.

Sensitivity Between BMI and IBC as Screening Tools for Overall Health and Nutritional Status: Insights from Hand Grip Strength Analysis Among Lebanese Adults

Sensibilidad entre el IMC y el ICC como Herramientas de Detección de la Salud General y el Estado Nutricional: Perspectivas del Análisis de la Fuerza de Agarre de la Mano entre Adultos Libaneses

Charbel Richa[1]; Zahi Andraos[2]; Marilyne El Mdawar[2]; Georges khoury[3] & Milivoj Dopsaj[1]

RICHA, C.; ANDRAOS, Z.; EL MDAWAR, M.; KHOURY, G. & DOPSAJ, M. Sensitivity between BMI and IBC as screening tools for overall health and nutritional status: Insights from hand grip strength analysis among Lebanese adults. *Int. J. Morphol., 42(6)*:1686-1693, 2024.

SUMMARY: This study aims to compare the sensitivity of Body Mass Index (BMI) and Body Composition Index (IBC) in identifying individuals with optimal health and nutritional status by evaluating their association with hand grip strength and explosive strength. A total of 303 healthy adult males and females were recruited. Anthropometric measurements and hand grip strength tests were conducted by standard procedure. Participants were categorized into low, normal, and high BMI groups, as well as under, normal, and high IBC groups. Descriptive statistics, MANOVA, and correlation analyses were performed to assess the correlation between BMI, IBC, and hand grip strength and explosive parameters. Significant differences were observed in hand grip strength and explosive strength across BMI and IBC groups. While BMI showed moderate positive correlations with absolute strength parameters, IBC exhibited stronger positive correlations with both absolute and relative strength parameters. Individuals with higher IBC demonstrated higher skeletal muscle mass and lower body fat percentage, despite lower BMI values. The study highlights the limitations of BMI in accurately reflecting body composition and suggests that IBC may offer a more sensitive assessment of health and nutritional status. Integrating alternative indices like IBC into health assessments could lead to more targeted interventions for improving health outcomes and reducing the burden of chronic diseases.

KEY WORDS: Index of body composition; Body mass index; Hand grip; Maximal force; Rate of force development.

INTRODUCTION

Maintaining optimal health is paramount for a meaningful and productive existence. Individuals who prioritize their health typically exhibit heightened levels of energy, reduced susceptibility to chronic ailments, and an enhanced overall quality of life (Vukovic *et al*., 2020). The assessment of body composition plays a pivotal role in identifying health-related risk factors, improving performance, and advocating for a healthy way of life. This process offers insights into specific health elements such as muscle mass and adipose tissue, aiding in the recognition of health variations among populations (Andraos *et al*., 2024).

The quantitative evaluation of health markers, including indices related to body composition, serves as indispensable tools for health surveillance. These metrics enable the early detection of potential health concerns and guide decisions regarding treatments and lifestyle adjustments. Body Mass Index (BMI) stands out as a commonly utilized measure for appraising body composition, determined by dividing an individual's weight by the square of their height (Gutierrez-Bedmar *et al*., 2015; Nuttall, 2015). Nevertheless, BMI possesses constraints due to its failure to accommodate variations in muscle mass and the distribution of body fat, rendering it an inadequate indicator of health and nutritional status (Romero-Corral *et al*., 2008).

The Index of Body Composition (IBC) emerges as an alternative metric, integrating additional factors such

[1] Faculty of Sports and Physical Education, University of Belgrade, Belgrade, Serbia.
[2] Laboratoire des 3S, Faculty of Sport Sciences, Antonine University, Lebanon.
[3] Faculty of Medicine, Lebanese American University, Lebanon.

Received: 2024-08-02 Accepted: 2024-09-07

as the ratio of body fat percentage to BMI, thereby presenting a more realistic evaluation of body composition and its health implications (Kukic *et al*., 2020a; Dopsaj *et al*., 2023). Furthermore, the assessment of hand grip strength, which measures the maximum force exerted by hand muscles, serves as a crucial method for evaluating overall health and physical robustness, with associations to various health outcomes including mortality and cardiovascular well-being. (Luna-Heredia *et al*., 2005; Wind *et al*., 2010; Sayer & Kirkwood, 2015; Amato *et al*., 2018; Neidenbach *et al*., 2019; Halaweh, 2020).

In light of the limitations of BMI and the potential advantages of IBC, it is imperative to assess their sensitivity in appraising general health and nutritional status. The aim of the study is to compare the efficacy of BMI and IBC in identifying individuals with optimal health and nutritional status among the Lebanese population. Through scrutinizing the correlation between these metrics and diverse health parameters, we can ascertain which index offers the most sensitive and precise evaluation of overall health status. Such research endeavors possess the capacity to influence clinical practices and public health interventions, ultimately enhancing health outcomes and alleviating the burden of chronic illnesses.

MATERIAL & METHOD

Participants. A total of 303 healthy adult males (N=179) and females (N=124) from diverse educational and training backgrounds and from all Lebanese regions were recruited to participate in the present study to ensure a diverse representation of individuals. A thorough summary of the general traits displayed by the study participants can be found in the section that follows. Important characteristics and traits that are unique to the research participants will be discussed in detail, providing a thorough picture of the study participants overall profile. For males, these are the characteristics: age: 30.6 ± 11.1 years, body height: 176.8 ± 7.2 cm, body mass: 81.3 ± 14.6 kg, body mass index: 25.98 ± 4.04 kg/m^2, percentage of skeletal muscle mass: 44.1 ± 6.2 %, percentage of body fat mass: 20.3 ± 7.9 %. As for females, these are the characteristics: age: 31.1 ± 12.2 years, body height: 163.2 ± 6.2 cm, body mass: 63.7 ± 12.2 kg, body mass index: 24.01 ± 4.58 kg/m^2, percentage of skeletal muscle mass: 32.8 ± 6.1 %, percentage of body fat mass: 32.6 ± 8.8 %.

The participants were healthy individuals, without hormonal disorders and limb injuries and were asked to avoid strenuous exercise 48 hours before the test and were required to abstain from consuming food and liquids for a minimum of 1.5 hours.

The research was realized according to the regulations of the Declaration of Helsinki and with the permission of the Ethics Committee at the University of Belgrade Faculty of Sport and Physical Education (02 No. 484-2).

Measurement procedures

Anthropometric measurements. Before the handgrip strength test began, each participant had a complete anthropometric assessment that included height and body composition measurements according to the previously described procedure (Andraos *et al*., 2024). With their backs firmly pressed against a level wall, participants stood barefoot and made sure their buttocks, heels, and shoulders were in contact with the wall in order to achieve an accurate measurement of their height using a New Med Digital stadiometer. A portable bioelectrical impedance analysis (BIA) body composition analyzer: the Mediana i30 is used to measure body composition metrics such as body mass (BM, in kg), body mass index (BMI, in kg/m^2), body fat mass (BFM, in kg), skeletal muscle mass (SMM, in kg), and percentage of body fat (PBF, in %). IBC – index of body composition, is calculated as a quotient between PBF and BMI, expressed in index units (Kukic *et al*., 2020a; Dopsaj *et al*., 2023). In addition, participants completed a thorough questionnaire intended to evaluate their general level of physical activity. This questionnaire included questions about the frequency, length, and intensity of their weekly training schedules, and provided important information regarding their regular exercise routines (Total min/week, expressed in minutes of total exercise during the week).

This study was conducted at the Antonine University Baabda, Lebanon, in the Laboratory of the 3S: Sport, Santé, Société (L3S).

Hand grip testing procedure. The isometric handgrip assessment followed standardized methodology (Dopsaj *et al*., 2019, 2022) using a handgrip apparatus with a fixed strain gauge (Sports Medical Solutions, All4gym d.o.o., Serbia). Participants sat upright, centrally on a chair, with one arm extended and grasping the measuring instrument. After receiving verbal instructions, participants performed two familiarization trials with moderate force, alternating hands randomly. After a 2-minute break, the handgrip assessment focused on the power grip. Participants applied maximum pressure on cue and maintained it for at least 2 seconds with verbal encouragement. Each hand was tested twice in a randomized order, with a 1-minute rest between trials.

Participants maintained their arms alongside their bodies, with the evaluated arm slightly abducted (5–10 cm). The maximal force was assessed using the maximum muscle force level achieved (Fmax, expressed in Newtons, N) and the maximal rate of force development (RFDmax, expressed in Newtons per second, N/s). RFDmax, which measures maximal explosivity, was calculated as the steepest slope on the force-time curve. Values were recorded from each trial using a laptop. The onset of contraction was identified when the first derivative of the force-time curve exceeded the baseline by 3 % compared to its maximum value. The strain gauge had an accuracy of ± 0.1 N, and the force-time signal was sampled at 500 Hz, followed by a low-pass filtration (10 Hz) using a fourth-order Butterworth filter. Data acquisition and processing were done with specialized software (Sports Medical Solutions Isometrics, ver. 3.4.0). Absolute Sum_F_{max} and sum_RFD_{max} values were calculated by summing the handgrip force and rate of force development for both hands, and then normalized by body weight to derive relative values. The best outcomes were used for subsequent data analysis and statistical investigations.

Statistical procedure. Descriptive statistics, including means, standard deviations (Mean ±SD), and data range (Min, Max), were calculated for all variables. Additionally, 95 % upper and lower confidence intervals were computed.

A multivariate analysis of variance (MANOVA) compared hand grip strength (HGS) for maximal force and rate of force development among individuals with low, normal, and high BMI, as well as low, normal, and high Index of Body Composition (IBC). Pearson's correlation analysis examined the relationship between HGS and hand grip explosive strength (HGES) with BMI and IBC. Fisher t-to-z transformations compared these correlations to determine significant differences, revealing stronger and more consistent relationships of IBC with HG parameters compared to BMI.

The sample was divided into three BMI groups: low (<18.5), normal (18.5-24.99), and high (>25.0), and re-categorized based on IBC using a 3D metrological technique. Both absolute and relative hand grip maximal force (Sum_F_{max}) and hand grip rate of force development (Sum_RFD_{max}) were evaluated, with relative values calculated by dividing absolute values by body mass for both BMI and IBC classifications (Sum_F_{rel}, and Sum_RFD_{rel}). Gender was not considered, and each group included both males and females.

All statistical analyses were conducted using SPSS Statistics 26.0 software, with a significance level set at 95 % and a p-value threshold of 0.05.

RESULTS

The study categorized individuals into three groups based on Body Mass Index (BMI) and Index of Body Composition (IBC) measurements. The findings are presented in Tables I and II.

The results in Table I highlight distinct differences in body size and proportions among individuals categorized by low, normal, and high BMI, as well as those categorized by low, normal, and high IBC. For the BMI categories, body height was the same for normal and high BMI groups, while those with low BMI were shorter. Body mass and BMI followed expected patterns, with high BMI individuals weighing more (85.3 ± 14.5 kg) and having a higher BMI (28.8 ± 3.25 kg/m^2) than those with normal and low BMI. The normal BMI group had the highest percentage of skeletal muscle mass (PSMM) at 41.2 ± 8.4 %, while the high BMI group had the highest percentage of body fat (PBF) at 29.8 ± 9.7 %. The index of body composition (IBC) values and physical activity levels also varied, with the normal BMI group being the most active.

In the IBC categories, individuals with high IBC were taller (178.3 ± 6.93 cm) than those with normal and low IBC. The normal IBC group had the highest body mass (80.8 ± 16.2 kg) and BMI (26.38 ± 4.05 kg/m^2), while the high IBC group had the highest PSMM (51.2 ± 3.2 %) and the lowest PBF (10.9 ± 3.1 %). The low IBC group had the highest PBF at 35.1 ± 7.2 %. Physical activity levels were highest in the high IBC group, averaging 529.7 ± 560.6 minutes per week, compared to the normal and low IBC groups. These findings illustrate the varying characteristics and health indicators across different BMI and IBC categories.

The results in Table II show the hand grip strength (HGS) variables across different BMI categories revealing significant differences. For Sum_F_{max} (N), individuals with high BMI exhibited significantly greater values (849.19 ± 276.84) compared to both low BMI (516.63 ± 168.98, p=0.001) and normal BMI groups (727.73 ± 234.01, p<0.001). In the case of Sum_RFD_{max} (N/s), significant differences were observed between low and normal BMI groups (2757.38 ± 1457.76 vs. 4374.93 ± 1594.44, p=0.037), as well as between low and high BMI groups (5034.26 ± 1950.91, p=0.01) and normal and high BMI groups (p=0.005). For Sum_F_{rel} (N/kg), normal BMI individuals had significantly higher values (11.01 ± 2.65) compared to high BMI individuals (9.88 ± 2.63, p=0.001). Additionally, Sum_RFD_{rel} (N/(s·kg)) showed a significant difference between normal (66.11 ± 19.36) and high BMI individuals (58.37 ± 19.49, p=0.002). These findings highlight the influence of BMI on both absolute and relative hand grip strength parameters, with high BMI associated with greater maximal force and rate of force development, while normal BMI demonstrated higher relative values.

Concerning the Index of Body Composition (IBC), significant differences were observed across all measured variables. For Sum_F_{max} (N), the high IBC group (1006.26 ± 188.57) demonstrated significantly greater maximal force compared to both the normal IBC group (877.28 ± 202.13, p=0.000) and the low IBC group (511.08 ± 101.15, p=0.000). Similarly, in terms of Sum_RFD_{max} (N/s), the high IBC group (6159.98 ± 1190.89) exhibited significantly higher rates of force development than the normal (5274.03 ± 1537.67, p=0.000) and low IBC groups (2914.77 ± 882.76, p=0.000). For relative maximal force (Sum_F_{rel}, N/kg), the high IBC group (13.75 ± 1.59) showed significantly greater values than both the normal (10.92 ± 1.93, p=0.000) and low IBC groups (8.11 ± 1.78, p=0.000). Lastly, the relative rate of force development (Sum_RFD_{rel}, N/(s·kg)) was highest in the high IBC group (84.37 ± 12.22), with significant differences observed compared to both normal (65.43 ± 15.69, p=0.000) and low IBC groups (46.31 ± 14.37, p=0.000). These findings indicate that higher IBC is associated with greater maximal and explosive force in both absolute and relative terms. In contrast, BMI categories showed differences between absolute and relative values, with high BMI generating the highest F_{max} and RFD_{max} in absolute terms, while normal BMI demonstrates the highest values in relative terms, and indicates inconsistent results in BMI compared to consistent results in IBC.

Table I. Measurements of body size and proportions among individuals with low, normal, and high BMI, as well as those with under, normal, and high IBC.

	BMI		
Variables	**Low (n = 8)**	**Normal (n = 152)**	**High (n = 143)**
Age (year)	28.2 ± 10.0	26.9 ± 8.3	35.1 ± 14.6
BH(cm)	164.3 ± 9.4	171.2 ± 8.8	171.1 ± 10.1
BM (kg)	46.5 ± 6.1	65.1 ± 9.1	85.3 ± 14.5
BMI($kg/m^{2)}$	17.19 ± 0.84	22.16 ± 1.78	28.8 ± 3.25
PSMM (%)	35.9 ± 9.8	41.2 ± 8.4	37.8 ± 7.7
PBF (%)	18.0 ± 7.2	21.8 ± 9.2	29.8 ± 9.7
IBC (AU)	1.22 ± 0.83	1.26 ± 0.70	1.1 ± 0.70
Total min/week (min)	15.00 ± 42.4	356.5 ± 413.5	234.5 ± 249.5

	IBC		
Variables	**Low (n = 99)**	**Normal (n = 142)**	**High (n = 50)**
Age (year)	29.4 ± 10.8	33.4 ± 13.2	24.5 ± 5.6
BH (cm)	162.9 ± 6.3	174.5 ± 8.1	178.3 ± 6.93
BM (kg)	64.4 ± 12.7	80.8 ± 16.2	73.2 ± 11.06
BMI (kg/m^2)	24.37 ± 4.81	26.38 ± 4.05	23.00 ± 2.81
PSMM (%)	31.3 ± 5.2	41.02 ± 4.68	51.2 ± 3.2
PBF (%)	35.1 ± 7.2	24.06 ± 5.6	10.9 ± 3.1
IBC (AU)	0.69 ± 0.58	1.13 ± 0.19	2.32 ± 1.03
Total min/week (min)	175.48 ± 235.1	288.5 ± 281.1	529.7 ± 560.6

SD: standard deviation, BH: body height, BM: body mass, BMI: body mass index, PSMM: percentage of skeletal muscle mass, PBF: percentage of body fat.

Table II. Multivariate Analysis of Variance (MANOVA) of Hand Grip Strength across Different BMI and IBC Categories (Mean ± SD)

	BMI Categories		
Variables	**Low BMI**	**Normal BMI**	**High BMI**
Sum_F_{max} (N)	516.63 ± 168.98	727.73 ± 234.01	849.19 ± 276.84**
Sum_RFD_{max} (N/s)	2757.38 ± 1457.76	4374.93 ± 1594.44*	5034.26 ± 1950.91**
Sum_F_{rel} (N/kg)	10.91 ± 2.29	11.01 ± 2.65**	9.88 ± 2.63
SUM_RFD_{rel} (N/s.kg))	57.12 ± 23.13	66.11 ± 19.36**	58.37 ± 19.49
	IBC Categories		
Variables	**Low IBC**	**Normal IBC**	**High IBC**
Sum_F_{max} (N)	511.08 ± 101.15	877.28 ± 202.13**	1006.26 ± 188.57**
Sum_RFD_{max} (N/s)	2914.77 ± 882.76	5274.03 ±	6159.98 ± 1190.89**
Sum_F_{rel} (N/kg)	8.11 ± 1.78	10.92 ± 1.93**	13.75 ± 1.59**
Sum_RFD_{rel} (N/s.kg))	46.31 ± 14.37	65.43 ± 15.69**	84.37 ± 12.22 **

*Pvalue <0.05; **Pvalue<0.01 Sum_F_{max}: sum of maximal force, Sum_RFD_{max}: sum of maximal rate of force development, Sum_F_{rel}: sum of relative value of maximal force, Sum_RFD_{rel}: sum of relative value of maximal rate of force development.

The table III compares correlations between BMI and IBC with analyzed force parameters using the Fisher t-to-z transformation to determine the significance of these differences.

The correlations between IBC and the force parameters were consistently higher than those for BMI. The Fisher t-to-z transformations indicate statistically significant differences between these correlations, with Z-values of 1.52 for Sum_F_{max}, 1.17 for Sum_RFD_{max}, 5.75 for Sum_F_{rel}, and 4.99 for Sum_RFD_{rel} (Table III). All comparisons yielded highly statistically significant p-values > 0.001. These results suggest that IBC is a more reliable indicator of force parameters compared to BMI, highlighting its potential superiority in predicting muscle performance and health outcomes.

Table III. Comparison of Correlations between BMI and IBC measurements with Hand Grip Strength Variables Using Fisher t-to-z transformation

Variables	Correlation (BMI)	Correlation (IBC)	Fisher t-to-z transformation – Z values	p-value
Sum_F_{max}	0.326	0.558	1.52	0.000
Sum_RFD_{max}	0.308	0.496	1.17	0.000
$Sum\ F_{rel}$	-0.249	0.620	5.75	0.000
$Sum\_\ RFD_{rel}$	-0.169	0.535	4.99	0.000

Sum_F_{max}: sum of maximal force, Sum_RFD_{max}: sum of maximal rate of force development, Sum_F_{rel}: sum of relative maximal force, SUM_RFD_{rel}: sum of relative maximal rate of force development.

DISCUSSION

The study aims to demonstrate that the Index of Body Composition (IBC) is a better screening tool than Body Mass Index (BMI) for identifying health risks and well-being.

Table II highlights significant differences in absolute hand grip strength among BMI groups (p<0.01), aligning with Liao (2016), who found a positive association between higher BMI and increased absolute hand grip strength. However, our study revealed that relative hand grip strength showed only one significant difference: higher relative hand grip maximal force in the normal BMI group compared to the high BMI group, with no significant difference between the normal and low BMI groups. The small sample size in the low BMI group (n=8) necessitates further research.

Liao (2016) and Lad *et al.* (2012), found that higher BMI results in the lowest relative hand grip strength, aligned with our findings. Our study introduces the novel variable of explosive strength within BMI groups, revealing that the high BMI group exhibited the highest levels of explosive strength compared to both the normal and low BMI groups (p<0.01). However, the normal BMI group showed higher relative RFDmax values compared to the high BMI group, with the difference being statistically significant (Tables I and II). No significant difference was observed between the normal and low BMI groups, possibly due to the small sample size of the low BMI group. Further studies are needed to determine if a clear difference exists between these two groups in relative values. This highlights the importance of considering both absolute and relative measures when assessing musculoskeletal function and physical performance.

Analysis based on IBC categories revealed notable differences in hand grip strength and explosive strength. The high IBC group (n=50) exhibited significantly greater absolute and relative measures compared to the normal (n=142) and low (n=99) IBC groups, with all p-values <0.01. For example (Table II), the high IBC group had the highest Sum_F_{max} (1006.26 ± 188.57), Sum_RFD_{max} (6159.98 ± 1190.89), Sum_F_{rel} (13.75 ± 1.59), and Sum_RFD_{rel} (84.37 ± 12.23).

The normal IBC group also displayed higher hand grip strength and explosive strength parameters compared to the low IBC group (p-values <0.01). These findings align with Dopsaj *et al.* (2023), who found a significant correlation between IBC and competitive success in female athletes in different sports. IBC was the most sensitive variable for delineating differences in body fat among individual sports, accounting for 37.9 % of observed variations. Further research is needed to fully understand IBC's implications and refine its applications.

In addition, Table III presents the correlation coefficients between BMI, IBC, and various force parameters. BMI shows moderate positive correlations with Sum_F_{max} (r=0.326, p<0.001) and Sum_RFD_{max} (r=0.308, p<0.001), indicating that higher BMI values are associated with greater absolute hand grip strength and explosive strength. These findings align with Liao (2016) and Alahmari *et al.* (2017), supporting BMI as a reliable predictor of hand grip strength.

IBC results of the study show stronger positive correlations with force parameters compared to BMI. Specifically, IBC demonstrates robust positive correlations with Sum_F_{max} (r=0.558, p<0.001), Sum_RFD_{max} (r=0.496, p<0.001), Sum_F_{rel} (r= 0.625, P<0.001) and Sum_RFD_{rel} (r=0.535, p<0.001), suggesting that the relationship between muscle mass and fat distribution generally has a significant impact on hand grip strength and explosive strength. This is consistent with Dopsaj *et al*. (2023), who found higher IBC values correlated with greater competitive success in female athletes in different sports.

The correlation analysis between IBC and force parameters reveals significant positive correlations with Sum_F_{rel} (r = 0.620, p < 0.001) and Sum_RFD_{rel} (r = 0.535, p < 0.001). This indicates that higher IBC values are associated with higher relative hand grip strength and rate of force development. In contrast, BMI showed negative correlations with relative force and rate of force development, suggesting BMI may not accurately reflect an individual's relative strength capabilities when adjusted for body composition.

The Fisher t-to-z transformation reveals significant differences in correlations between BMI and IBC with hand grip strength variables. IBC consistently shows higher correlations, which provides stronger evidence that it is a more accurate indicator of muscle performance and health outcomes than BMI (Table III). "he Z-values (1.52 for Sum_F_{max}, 1.17 for Sum_RFD_{max}, 5.75 for Sum_F_{rel}, and 4.99 for Sum_RFD_{rel}) and highly significant p-values (all < 0.001) highlight the robustness of IBC in assessing good health and fitness status. These results suggest that IBC is a better predictor than BMI for assessing musculoskeletal function and physical performance. This finding aligns with earlier research conducted on various police officer populations (Kukic *et al*., 2020a,b).

While BMI provides information about body size, calculated as the amount of body mass (kg) per height squared (m^2), it is a quantitative measure of a person's body. However, IBC is a qualitative measure because it gives the ratio of contractile mass (muscles), which is the physiological basis for high-quality motor abilities, to ballast mass (fat), an indicator of poor nutrition and insufficient physical activity, often associated with “an unhealthy lifestyle."

In line with this difference, the high BMI group had the highest percentage of body fat (PBF) but not the highest percentage of skeletal muscle mass (PSMM). Higher PSMM is crucial for greater strength and functionality, while low PSMM is associated with adverse health outcomes, including decreased strength (Heymsfield *et al*., 2014), increased risk of falls (Cruz-Jentoft *et al*., 2010), metabolic disturbances (Srikanthan & Karlamangla, 2011), loss of independence (Baumgartner *et al*., 1998), and reduced quality of life (Janssen *et al*., 2004).

In contrast, IBC classification revealed that despite having a lower BMI, the high IBC group exhibited significantly higher PSMM, with a 19.88 % increase compared to the normal IBC group and a 38.86 % increase compared to the low IBC group. The difference in PSMM between the normal and low IBC groups was 23.7 %. The high IBC group had the lowest PBF, whereas the low IBC group had the highest. Differences in PBF were 31.45 % between the low and normal IBC groups, and 68.9 % between the low and high IBC groups. Additionally, the high IBC group displayed the highest level of physical activity, underscoring the association between body composition and lifestyle factors (Table I).

The results according to IBC show consistent findings for both absolute and relative values, while contrasting results emerged when categorizing participants by BMI. These findings suggest that IBC is more effective in evaluating the health and nutritional status of the Lebanese population.

CONCLUSION

In conclusion, this study underscores the importance of reevaluating traditional metrics like Body Mass Index (BMI) and exploring alternative indices such as the Index of Body Composition (IBC) for assessing general health and nutritional status. While BMI has long been used as a simple measure of body fatness and health risk, its limitations in accurately reflecting body composition are becoming increasingly evident. Through a comprehensive analysis of BMI and IBC in relation to hand grip strength and explosive strength, this research demonstrates that IBC may offer a more effective and nuanced assessment of general health and nutritional status. Notably, individuals categorized by IBC showed significant differences in body composition metrics. The high IBC group demonstrated higher skeletal muscle mass and a lower body fat percentage, despite having lower BMI values. These findings underscore the importance of considering both absolute and relative measures of body composition when evaluating musculoskeletal function and overall health. Moving forward, further research and clinical practice should prioritize integrating alternative indices like IBC to enhance health assessments and promote more targeted interventions aimed at improving health outcomes and reducing the burden of chronic diseases.

Limitations. Limitations of this study include the limited representation of individuals with low BMI, which may be due to either an inadequate sample size or a lower prevalence of low BMI individuals within the Lebanese population's body typology (Andraos *et al*., 2024). Consequently, future research should address this limitation to ensure a more balanced representation across BMI categories.

Additionally, while this study utilized classifications based on BMI and IBC, the influence of gender on these classifications was not explored. Future investigations should consider incorporating gender as a factor in the classification criteria to assess its potential impact on the findings, allowing for a more nuanced understanding of the relationships observed.

RICHA, C.; ANDRAOS, Z.; EL MDAWAR, M.; KHOURY, G. y DOPSAJ, M. Sensibilidad entre el IMC y el IBC como herramientas de detección de la salud general y el estado nutricional: perspectivas del análisis de la fuerza de agarre de la mano entre adultos libaneses. *Int. J. Morphol., 42(6)*:1686-1693, 2024.

RESUMEN: Este estudio tuvo como objetivo comparar la sensibilidad del índice de masa corporal (IMC) y el índice de composición corporal (ICC) para identificar a individuos con un estado nutricional y de salud óptimos, mediante la evaluación de su asociación con la fuerza de agarre de la mano y la fuerza explosiva. Se reclutó a un total de 303 hombres y mujeres adultos sanos. Se realizaron mediciones antropométricas y pruebas de fuerza de agarre de la mano mediante el procedimiento estándar. Los participantes se clasificaron en grupos de IMC bajo, normal y alto, así como en grupos de ICC bajo, normal y alto. Se realizaron estadísticas descriptivas, MANOVA y análisis de correlación para evaluar la correlación entre el IMC, el ICC y la fuerza de agarre de la mano y los parámetros explosivos. Se observaron diferencias significativas en la fuerza de agarre manual y la fuerza explosiva entre los grupos de IMC e ICC. Mientras que el IMC mostró correlaciones positivas moderadas con los parámetros de fuerza absoluta, el ICC exhibió correlaciones positivas más fuertes con los parámetros de fuerza absoluta y relativa. Las personas con mayor ICC demostraron una mayor masa muscular esquelética y un menor porcentaje de grasa corporal, a pesar de los valores de IMC más bajos. El estudio destaca las limitaciones del IMC para reflejar con precisión la composición corporal y sugiere que el ICC puede ofrecer una evaluación más sensible del estado de salud y nutricional. La integración de índices alternativos como el ICC en las evaluaciones de salud podría conducir a intervenciones más específicas para mejorar los resultados de salud y reducir la carga de enfermedades crónicas.

PALABRAS CLAVE: Índice de composición corporal; Índice de masa corporal; Agarre manual; Fuerza máxima; Tasa de desarrollo de la fuerza.

REFERENCES

Alahmari, K. A.; Silvian, S. P.; Reddy, R. S.; Kakaraparthi, V. N.; Ahmad, I. & Alam, M. M. Hand grip strength determination for healthy males in Saudi Arabia: A study of the relationship with age, body mass index, hand length and forearm circumference using a hand-held dynamometer. *J. Int. Med. Res., 45(2)*:540-8, 2017.

Amato, A.; Baldassano, S.; Cortis, C.; Cooper, J. & Proia, P. Physical activity, nutrition, and bone health. *Hum. Mov., 19(4)*:1-10, 2018.

Andraos, Z.; Dagher, M.; Richa, C. & Dopsaj, M. Body typology of Lebanese adults: Initial cluster cross-selection study. *Int. J. Morphol., 42(3)*:561-566, 2024.

Baumgartner, R. N.; Koehler, K. M.; Gallagher, D.; Romero, L.; Heymsfield, S. B.; Ross, R. R.; Garry, P. J. & Lindeman, R. D. Epidemiology of sarcopenia among the elderly in New Mexico. *Am. J. Epidemiol., 147(8)*:755-63, 1998.

Cruz-Jentoft, A. J.; Baeyens, J. P.; Bauer, J. M.; Boirie, Y.; Cederholm, T.; Landi, F.; Martin, F. C.; Michel. J. P.; Rolland, Y.; Schneider, S. M.; *et al*. Sarcopenia: European consensus on definition and diagnosis. *Age Ageing, 39(4)*:412-23, 2010.

Dopsaj, M.; Andraos, Z.; Richa, C.; Mitri, A.; Makdissi, E.; Zoghbi, A.; Dandachi, R.; Erlikh, V. V.; Cherepov, E. A.; Masiulis, N.; *et al*. Maximal and explosive strength normative data for handgrip test according to gender: Int. standardization approach. *Hum. Mov., 23(4)*:77-87, 2022.

Dopsaj, M.; Nenasheva, A. V.; Tretiakova, T. N.; Surina-Marysheva, E. F.; Markovic, S. & Dopsaj, V. Handgrip muscle force characteristics with general reference values at Chelyabinsk and Belgrade students. *Hum. Sport Med., 19(2)*:27-36, 2019.

Dopsaj, M.; Silgeg, K. & Milic, R. Reference values and sensitivity for different body fat variables measured by bioimpedance method in female athletes in individual sports: discriminative and comparative study. *Int. J. Morphol., 41(3)*:717-24, 2023.

Gutierrez-Bedmar, M.; Villalobos Martínez, E.; Garcia-Rodriguez, A.; Munoz-Bravo, C. & Mariscal, A. Psychiatric status across body mass index in a Mediterranean Spanish population. *PLoS One, 10(12)*:e0145414, 2015.

Halaweh, H. Correlation between health-related quality of life and hand grip strength among older adults. *Exp. Aging Res., 46(2)*:178-91, 2020.

Heymsfield, S. B.; Adamek, M.; Gonzalez, M. C.; Jia, G. & Thomas, D. M. Assessing skeletal muscle mass: historical overview and state of the art. *J. Cachexia Sarcopenia Muscle, 5(1)*:9-18, 2014.

Janssen, I.; Shepard, D. S.; Katzmarzyk, P. T. & Roubenoff, R. The healthcare costs of sarcopenia in the United States. *J. Am. Geriatr. Soc., 52(1)*:80-5, 2004.

Kukic, F.; Heinrich, K. M.; Koropanovski, N.; Poston, W. S.; Cvorovic, A.; Dawes, J. J.; Orr, R. & Dopsaj, M. Differences in body composition across police occupations and moderation effects of leisure time physical activity. *Int. J. Environ. Res. Public Health, 17(18)*:6825, 2020a.

Kukic, F.; Koropanovski, N.; Jankovic, R.; Svorovic, R.; Dawes, J. J.; Lockie, R.G.; Orr, R.M. & Dopsaj, M. Association of sex-related differences in body composition to change of direction speed in police officers while carrying load. *Int. J. Morphol., 38(3)*:731-6, 2020b.

Liao, K. H. Hand grip strength in low, medium, and high body mass index males and females. *Middle East J. Rehabil. Health, 3(1)*:e53229, 2016.

Luna-Heredia, E.; Martín-Peña, G. & Ruiz-Galiana, J. Handgrip dynamometry in healthy adults. *Clin. Nutr., 24(2)*:250-8, 2005.

Neidenbach, R. C.; Oberhoffer, R.; Pieper, L.; Freilinger, S.; Ewert, P.; Kaemmerer, H.; Nagdyman, N.; Hager, A. & Müller, J. The value of hand grip strength (HGS) as a diagnostic and prognostic biomarker in congenital heart disease. *Cardiovasc. Diagn. Ther., 9(Suppl. 2)*:S187-S97, 2019.

Nuttall, F. Q. Body mass index: obesity, BMI, and health: a critical review. *Nutr. Today, 50(3)*:117-28, 2015.

Romero-Corral, A.; Somers, V. K.; Sierra-Johnson, J.; Thomas, R. J.; Collazo-Clavell, M. L.; Korinek, J. E. C.; Allison, T. G.; Batsis, J. A.; Sert-Kuniyoshi, F. H. & Lopez-Jimenez, F. Accuracy of body mass index in diagnosing obesity in the adult general population. *Int. J. Obes. (Lond.), 32(6)*:959-66, 2008.

Sayer, A. A. & Kirkwood, T. B. Grip strength and mortality: a biomarker of ageing? *Lancet, 386(9990)*:226-7, 2015.

Srikanthan, P. & Karlamangla, A. S. Muscle mass index as a predictor of longevity in older adults. *Am. J. Med., 127(6)*:547-53, 2011.

Vukovic, M.; Kukic, F.; Cvorovic, A.; Jankovic, D.; Prcic, I. & Dopsaj, M. Relations between frequency and volume of leisure-time physical activity and body composition in police officers. *Res. Q. Exerc. Sport, 91(1)*:47-54, 2020.

Wind, A. E.; Takken, T.; Helders, P. J. M. & Engelbert, R. H. H. Is grip strength a predictor for total muscle strength in healthy children, adolescents, and young adults? *Eur. J. Pediatr., 169(3)*:281-7, 2010.

Corresponding author:
Zahi Andraos
Faculty of Sport Sciences
Antonine University
Hadat-Baabda
LEBANON

E-mail: zahy.andraos@hotmail.com