Adherence to the Mediterranean diet, kinanthropometric characteristics and physical performance of young male handball players

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Introduction: Handball is a team sport whose performance depends on a large number of factors. The objectives of the present study were to analyze the differences in physical performance, kinanthropometric variables, and adherence to the Mediterranean diet (MD), in handball players according to sports category, as well as the possible relationships between these variables.**Methods**: One hundred and thirty-three male handball players (35 infant; 46 cadets; 26 juniors and 26 seniors players) underwent a kinanthropometric analysis following the ISAK protocol, self-completed the KIDMED questionnaire, and their physical condition was evaluated with different physical tests.**Results**: Significant differences (p<0.001-0.007) were found between the sports categories in most of the physical condition variables and anthropometric characteristics, but not in the degree of adherence to the MD. The predominant level of adherence to the MD was medium (47.4%), followed by good (42.1%), and correlated with the body mass, the height, the BMI, the muscle mass and the ∑3-girths sum corrected, but not with physical test results. A multiple linear regression analysis showed that the fat mass and muscle mass variables had a more specific weight in the results of the physical fitness tests.**Conclusions**: There are differences according to sports category in kinanthropometric characteristics and physical fitness tests in adolescent handball players. The predominant degrees of adherence to the MD were medium and good. A relationship was found between anthropometric characteristics and physical performance in handball players.

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Abstract

Introduction: Handball is a team sport whose performance depends on a large number of factors. The objectives of the present study were to analyze the differences in physical performance, kinanthropometric variables, and adherence to the Mediterranean diet (MD), in handball players according to sports category, as well as the possible relationships between these variables.

Methods: One hundred and thirty-three male handball players (35 infant; 46 cadets; 26 juniors and 26 seniors players) underwent a kinanthropometric analysis following the ISAK protocol, self-completed the KIDMED questionnaire, and their physical condition was evaluated with different physical tests.

Results: Significant differences ($p<0.001$-0.007) were found between the sports categories in most of the physical condition variables and anthropometric characteristics, but not in the degree of adherence to the MD. The predominant level of adherence to the MD was medium (47.4%), followed by good (42.1%), and correlated with the body mass, the height, the BMI, the muscle mass and the ∑3-girths sum corrected, but not with physical test results. A multiple linear regression analysis showed that the fat mass and muscle mass variables had a more specific weight in the results of the physical fitness tests.

Conclusions: There are differences according to sports category in kinanthropometric characteristics and physical fitness tests in adolescent handball players. The predominant degrees of adherence to the MD were medium and good. A relationship was found between anthropometric characteristics and physical performance in handball players.

Introduction

Handball is a complex, multifactorial, and high-contact team sport, in which different actions, movements or plays occur intermittently at very high intensity (Martínez-Rodríguez et al., 2020). These periods alternate with brief moments of low intensity that serve as a recovery period before the next play (Hermassi, Laudner & Schwesig, 2019; Hermassi et al., 2020). All these situations are influenced by the physical capabilities of the players themselves highlighting strength, endurance, speed, and flexibility (Hammami et al., 2019; Molina-López et al., 2020).

Considering the characteristics of the game, there is no doubt that handball players need to have a correct physical preparation to be able to overcome all the physical demands and supply the energy required during a training session or match. Such physical preparation is related to the anthropometric characteristics and body composition of the individual players, which influence their performance during competition (Ghobadi et al., 2013; Martínez-Rodríguez et al., 2020). In fact, both the anthropometry and body composition of the players are important factors that determine performance within a team (Matthys et al., 2013).

Generally speaking, players that make up elite teams are tall, with low body fat values, and good muscle development (Vila et al., 2012; Ghobadi et al., 2013). In fact, greater muscle mass also implies improved performance, probably due to increased maximal strength and muscle power

60   (Granados et al., 2015). However, researchers have not yet been able to establish a consensus to
61   be able to exactly define which anthropometric characteristics are more related or have a greater
62   influence on the improvement of performance in handball players.
63   Another factor that may have a strong influence is the athlete's diet (Kerksick et al., 2018). In
64   fact, organizations with great international prestige insist that the performance of athletes, as well
65   as their recovery, can be improved with optimal nutrition (Thomas, Erdman & Burke, 2016).
66   With respect to nutrition, it is known that the Mediterranean Diet (MD) is a healthy diet model
67   which is characterized by a high consumption of fruits, vegetables, cereals, nuts, legumes and
68   olive oil; a moderately high consumption of fish; a moderate consumption of dairy products; and
69   a low consumption of meat, poultry and foods with saturated fats. A good adherence to MD has
70   been associated with certain physical benefits and high levels of health-related quality of life
71   (Galan-Lopez et al., 2018, 2019, 2020; Manzano-Carrasco et al., 2020a). This could be because
72   good adherence to this dietary pattern provides a balanced intake of macronutrients such as
73   complex carbohydrates, unsaturated fats and high biological value proteins, as well as
74   micronutrients such as vitamins and minerals (Davis et al., 2015). This adequate intake of
75   macronutrients and micronutrients could favor the energy availability of athletes during
76   competition, promote physiological processes and prevent a positive energy balance that leads to
77   fat accumulation (Tosti, Bertozzi & Fontana, 2018). However, very few studies have analyzed
78   adherence to the MD in young athletes, and how it influences sports performance, body
79   composition characteristics, or both, not finding a high adherence of young athletes to this
80   dietary pattern. (Rubio-Árias et al., 2015; Vaquero-Cristóbal et al., 2018; Manzano-Carrasco et
81   al., 2020b; Martínez-Rodríguez et al., 2021). In addition, no studies have been found about
82   handball players.
83   Therefore, the objectives of the present study were: a) to observe whether there is any difference
84   between anthropometric characteristics, sports performance, and adherence to the MD depending
85   on the sports category of handball players; b) to know the degree of adherence to the MD of the
86   players; c) to know whether this degree of adherence to the MD influences sports performance
87   and anthropometric characteristics; d) to know whether there is a relationship between
88   anthropometric characteristics and sports performance. The hypotheses of this study were: 1)
89   athletes of higher categories would show a greater optimization of anthropometric characteristics
90   and better results in the physical condition tests than their equivalent athletes of lower categories;
91   2) adolescent handball players would have a heterogeneous adherence to DM, with no clear
92   pattern in this regard; 3) a better adherence to DM would positively influence the presence of
93   more optimal anthropometric parameters and sports performance; and 4) adolescent handball
94   players with better body composition, that is, with greater muscle development and a lower
95   adipose component, and with good adherence to DM will have better results in physical fitness
96   tests related to handball performance.
97
98   ## Materials & Methods
99   *Study design*

100   The present study was carried out by means of a descriptive-correlational cross-sectional study in
101   which anthropometric characteristics, adherence to the Mediterranean diet, and performance in
102   different physical tests, were evaluated in young handball players. The sample size calculation
103   was performed with Rstudio software (version 3.15.0, Rstudio Inc., Boston, MA, USA). The
104   significance level was set a priori at α=0.05. The standard deviation (SD) was set according to
105   the muscle mass data from previous studies in adolescent athletes (SD= 2.59) (Albaladejo-Saura
106   et al., 2022). With an estimated error (d) of 0.44 kg, the sample size needed was 133 subjects.
107   The study population was selected through non-probabilistic convenience sampling among clubs
108   with infant, cadet, junior and senior categories in the provinces of Alicante and Murcia (Spain).
109   *Participants*
110   One hundred and thirty-three male handball players between 12 and 28 years of age voluntarily
111   participated in this study. They were divided according to the category in which they competed,
112   with the final sample being 35 infant (mean age: 13.41 ± 0.40 years), 46 cadets (mean age: 14.83
113   ± 0.64 years), 26 juniors (mean age: 17.20 ± 0.55 years), and 26 seniors (mean age: 20.09 ± 2.76)
114   years. The inclusion criteria for the study were: a) at least two years playing handball; b) being
115   federated in handball; c) training a minimum of three days per week; and d) training for at least
116   one month without missing any training. The exclusion criteria for the study were: a) being
117   injured at the time of the evaluations.
118   *Procedure*
119   The study was approved by the Ethics Committee of the University of Alicante (code: UA-2022-
120   02-01). In addition, all the players were previously informed about the objective and method of
121   the study, and signed the informed consent before starting the study, or their parents or legal
122   guardians, failing this, in the case of minors.
123   The measurements were performed in the same week in three evaluation sessions, leaving one
124   rest day between the second and third evaluation day. On the measurement days, the players
125   should not have performed high-intensity exercise the previous day, nor should they have
126   performed training or stretching sessions on the same day. On the first day, kinanthropometric
127   characteristics and adherence to the MD were evaluated; on the second day, agility and
128   endurance tests were performed; and on the last day, jumping, throwing, and sprinting tests were
129   completed, always leaving five minutes of rest between tests.
130   *Adherence to the Mediterranean Diet.*
131   To analyze adherence to the MD, participants self-completed the questionnaire that assessed MD
132   quality index in children and adolescents (KIDMED, KM). With a maximum score of 12 points,
133   responses were categorized according to the level of quality of MD: ≤3 poor quality, 4-7 medium
134   quality and ≥8 optimal quality (Serra-Majem et al., 2004).
135   *Kinanthropometric evaluation.*
136   The kinanthropometric evaluation was performed by an anthropometrist level 2 accredited by the
137   International Society for the Advancement of Kinanthropometry (ISAK), with a technical
138   measurement error of 0.03% for basic measurements, 2.24% for skinfolds and 0.36% for girths,
139   and following the international standards recommended by the ISAK (Esparza-Ros, Vaquero-

140 Cristóbal & Marfell-Jones, 2019). The following variables were taken: the four basic
141 measurements (body mass, height, sitting height y arms span), three skinfolds (triceps, thigh and
142 leg), and four girths (relaxed and contracted arm, thigh and leg). For the determination of body
143 mass, a SECA 862 scale (SECA, Germany), with an accuracy of 100 g was used; for height and
144 sitting height, a SECA 217 (SECA, Germany) measuring rod with a 1 mm accuracy was used;
145 and for wingspan, an Avanutri wingspan meter (Avanutri, Brazil); for girths, a CESCORF metal
146 tape (CESCORF, Brazil) was used; and for skinfolds, a Slimguide plicometer (Creative Health
147 Products, United States) with a 0.5mm precision was utilized. All the anthropometric
148 measurements were taken two or three times, depending on whether the difference between the
149 first two was greater than 5% for skinfolds, and 1% in the rest of the measurements, taking the
150 mean or median, respectively, for subsequent analyses. The temperature of the room where the
151 measurements were taken was standardized at 24 ºC, and all measurements were taken from
152 15:00 to 21:00.
153 With the data collected, the following were estimated: body mass index (BMI), with the formula
154 body mass (kg) / height (m)2 (Alvero Cruz et al., 2010); the percentage of fat mass (FM)
155 (Slaughter et al., 1988) and muscle mass (MM) (Poortmans et al., 2005), with the formulas
156 chosen because they have been validated in a growing population (Alvero Cruz et al., 2010); $\sum3$
157 skinfolds (triceps, thigh and leg); and $\sum3$-girths sum corrected (relaxed arm, thigh and leg), with
158 the formula corrected perimeter = perimeter - π x fold (Alvero Cruz et al., 2010).
159 *Physical condition*
160 The T-Half Test protocol (Sassi et al., 2009) was used to evaluate the agility of the players. This
161 test was chosen because unlike the T-Test, it is shorter in distance and more representative for
162 handball. To monitor the start and end of the test, a photocell (Witty, Microgate, Italy) was used.
163 The endurance capacity of the players was evaluated following the protocol of the Intermittent
164 Recovery Yo-Yo level 1 test (Krustrup et al., 2003). In addition to recording the total meters run
165 by each athlete in this test, the theoretical VO_2 max was estimated using the equation of Bangsbo
166 et al. (2008), which has been previously used in similar contexts (Gonçalves & Carvalho, 2021;
167 Macpherson & Weston, 2015; Köklü, 2012).
168 To assess the jumping ability of the players, they were asked to perform the Squad Jump (SJ) and
169 Counter Movement Jump (CMJ). The latest version of the MyJump application (Balsalobre-
170 Fernández, Glaister & Lockey, 2015) was used to measure the jumps, and a previously described
171 protocol was used (Hermassi et al., 2021).
172 To assess the players' upper limb power, they were given the overhead medicine ball throw test,
173 and a tape measure (Haest, Germany) with 0.1 cm accuracy was used to measure the distance
174 (Albaladejo-Saura et al., 2022).
175 For the assessment of speed, a 30-m sprint was performed at the maximum possible intensity. To
176 monitor the start and end of the test, two photocells (Witty, Microgate, Italy) were used.
177 The players performed two valid attempts of the agility, jump, throw, and sprint tests, and one
178 attempt of the endurance test. A familiarization with the physical test protocols was performed
179 the week before the measurements. In addition, before sessions 2 and 3, a standardized warm-up

180   was performed consisting of 10 minutes of continuous running at a gentle jog, dynamic joint
181   mobility exercises and low-intensity exercises, simulating the tests they were going to perform in
182   that session. The researchers encouraged the players to perform the physical tests at the
183   maximum possible intensity.

184   *Statistical analysis.*

185   Both the kinanthropometric characteristics of the players, as well as adherence to the MD and the
186   results obtained in the performance tests, were analyzed using descriptive statistics, to obtain the
187   mean and standard deviation. The Kolmogorov-Smirnov normality test was performed to
188   evaluate that all variables had a normal distribution. The kurtosis was also evaluated, and the
189   Mauchly sphericity test was performed to test the sphericity of the data. Given the normal
190   distribution of the data and to analyze the differences between the categories in the
191   anthropometric variables, adherence to MD, and the results of the physical tests, an analysis of
192   variance (ANOVA) was performed, as well as an analysis of covariance (ANCOVA) to observe
193   the influence of the covariate age. When significant differences were found between groups, a
194   pairwise comparison was performed using the Bonferroni correction for multiple comparisons. In
195   addition, a bivariate correlation was performed between the kinanthropometric characteristics of
196   the players and adherence to MD with the results obtained from the physical tests. The
197   association between these variables was measured as follows: $r < 0.3$, low association; $r = 0.3$ -
198   0.5, moderate association; and $r > 0.5$, high association. Finally, a stepwise linear regression
199   analysis was performed on all the variables that were found to correlate with the physical fitness
200   tests. As for the categorical variables, a chi-square test ($\chi2$) was performed to analyze the
201   distribution of the degree of adherence to the Mediterranean diet. The minimum level of
202   statistical significance was set at $p < 0.05$. All the data were analyzed using the Statistical
203   Package for the Social Sciences (SPSS) version 25.0 (IBM, United States).

204

Results

206   Table 1 shows the descriptive statistics (mean ± standard deviation) of all measured variables, as
207   well as the differences between groups, the main effects of the covariate age and the interaction
208   of the category*age model. When comparing results among categories, significant differences (F
209   = 4.259-58.408; $p < 0.001$-0.007) were found for all measured variables, with the exception of
210   the KM score (F = 1.773; $p = 0.156$). When comparing participants according to age, significant
211   differences were found in all variables (F = 78.554-9.563; $p < 0.001$-0.002), except for FM, ∑3-
212   skinfolds, KM score and the distance and the VO2max in the YoYo test (F = 3.603-0.266; $p =$
213   0.060-0.607). The interaction between category and age also showed significant differences in all
214   measured variables (F = 43.773 - 3.196; $p < 0.001$ - 0.015), except for the KM score (F = 1.446;
215    $p = 0.223$).

216   -Insert Table 1 here-

217   With respect to the anthropometric variables (Table 2), it was found that the infant category
218   showed significantly lower values with the majority of the other categories in body mass, height,
219   BMI, MM and girths corrected sum, and significantly higher values respect the majority of the
220   other categories in the percentage of FM and ∑3-skinfolds ($p < 0.002$ - 0.021. The cadet category
221   compared to the junior category, showed significantly lower values in body mass, height, MM

222   and ∑3-girths sum corrected (p < 0.001 - 0.009). Regarding the comparison between cadets and
223   seniors, it was found that cadets showed significantly lower values in body mass, BMI, MM and
224   ∑3-girths sum corrected (p < 0.001). No significant differences were found between junior and
225   senior categories (p > 0.05).
226   Regarding the differences in the physical fitness variables between categories (Table 3), the
227   infant category showed a worse sports performance in the medicine ball throw, T-Half test, SJ,
228   CMJ, sprint and Yo-Yo test variables (p < 0.000 - 0.026). The cadet category compared to the
229   junior category, showed significantly worse performance in the medicine ball throw, T-Half test,
230   SJ y CMJ (p < 0.001 - 0.005). Regarding the comparison between cadets and seniors, it was
231   found that cadets showed significantly lower distance in the medicine ball throw (p < 0.001). On
232   the other hand, in the comparison of the junior and senior categories, junior category showed
233   significantly higher differences in the SJ jump test (p < 0.003). The category*age group
234   interaction showed that age had a significant influence (p < 0.001-0.038) on most of the variables
235   studied as soon as the infant and cadet categories were compared with any of the other
236   categories, with the exception of the BMI variable which showed no differences in any
237   comparison (p = 0.236-1.000).
238   -Insert Table 2 here-
239   -Insert Table 3 here-
240   Table 4 shows the distribution (%) of the degree of adherence to MD, calculated by the score
241   obtained in the KIDMED questionnaire, according to category. No significant difference was
242   found between categories (p = 0.204). However, the infant and senior categories had the fewest
243   players with poor adherence (2.9% and 7.7%, respectively), while the infant and junior
244   categories had the most players with good adherence (54.3% and 50.0%, respectively). With
245   respect to the total, only 10.5% had a poor level of adherence, while the predominant level was
246   medium with 47.4%.
247   -Insert Table 4 here-
248   All figures show the bivariate correlations between anthropometric characteristics and physical
249   test results, and between KIDMED score and both. The KIDMED questionnaire showed low
250   negative correlations with body mass, height, BMI, MM and ∑3-girths sum corrected (r = -0.190
251   to -0.236; p < 0.006-0.019), whereas it did not correlate with any variable from the the physical
252   tests (r = -0.148 to 0.061; p = 0.088-0.956) (Figure 1). Upper limb power, assessed with the
253   medicine ball throw, showed high positive correlations with age, body mass, height, BMI, MM
254   and ∑3-girths sum corrected (r = 0.535 to 0.784; p < 0.001) (Figure 2). In the agility test (T-Half
255   Test), low to moderate negative correlations were found between the time taken to complete the
256   run, with age, height, MM and ∑3-girths sum corrected (r = -0.397 to -0.179; p < 0.001-0.039),
257   and moderate positive correlations with both FM and ∑3-skinfolds (r = 0.387 to 0.389; p <
258   0.001-0.03) (Figure 3). The SJ (Figure 4) and CMJ (Figure 5) showed low to moderate positive
259   correlations with age, height, and MM (r = 0.180 to 0.489; p < 0.001-0.038), and low to
260   moderate negative correlations with FM and the ∑3-skinfolds (r = -0.427 to -0.537; p < 0.001).
261   In addition, the CMJ was also positively correlated with a low association with the ∑3-girths
262   sum corrected (r = 0.197; p < 0.023). In speed, with a longer time in sprint indicating a worse
263   performance, low to moderate negative correlations were observed with both age and height (r =
264   -0.261 to -0.445; p < 0.001 - 0.002), and high positive correlations with both FM and ∑3-
265   skinfolds (r = 0.636 to 0.645; p < 0.001) (Figure 6). Regarding endurance, both distance (Figure

266 7) and VO$_2$ max (Figure 8), low to high negative correlations were observed with BMI, FM and
267 ∑3-skinfolds (r = -0.540 to -0.294; p < 0.001), and low positive correlation with height (r =
268 0.219; p < 0.011).
269 Table 5 shows the multiple linear regression analysis, as well as the resulting predictive
270 equations for physical capacity and KIDMED score. With the exception of the latter, where the
271 independent variable included only explained 7% of its variability (p = 0.006), the
272 anthropometric characteristics included in each model explained 32% to 72% of the variability of
273 the physical test results (p < 0.001). The most determinant anthropometric characteristics were
274 MM and FM.
275   -Insert Figures 1-8 here-
276   -Insert Table 5 here-
277

278 **Discussion**
279 The main objective was to observe if there were any differences in the anthropometric
280 characteristics, adherence to MD and physical condition as a function of the sports category in
281 handball. It was found that there were significant differences between the categories compared,
282 both in most of the anthropometric characteristics, and in the results of the physical tests; while
283 no significant differences were found between the groups studied in the distribution of the degree
284 of adherence to the MD. In this study, it was found that when the players were part of a category
285 whose age range was older, most of the anthropometric characteristics also increased, with the
286 exception of FM and ∑3-skinfolds, and that the results in the physical tests were better. Hermassi
287 et al., 2020 also found differences in all kinanthropometric parameters between age groups in
288 handball players, with the exception of body fat percentage. However, for the physical tests, they
289 found no significant differences, with the exception of upper limb power in the medicine ball
290 throw test. This could possibly be due to the fact that their study population were young players
291 aged 10 to 12 years old, so the maturation process, with all the hormonal changes that it entails,
292 had not yet begun. Molina-López et al., 2020 found the same results as the present work for both
293 anthropometric characteristics and physical test results in handball players. Moreover, as in this
294 study, the differences between categories were reduced or even not observed when comparing
295 groups further away from puberty, which could be due to the stabilization of the maximum
296 growth peak, and the end of the maturation process (Albaladejo-Saura et al., 2021). Therefore, as
297 players grow older, their body composition changes (Albaladejo-Saura et al., 2022), as can be
298 hypothesized by analyzing the results of the present investigation, allowing in most cases, to
299 have a better performance in physical fitness tests (Albaladejo-Saura et al., 2021). However, this
300 improvement in body composition and performance is also influenced by other reasons, such as
301 the level of play or hours of training (Hammami et al., 2019), so more research is still lacking for
302 a better understanding of the factors that affect body composition and performance of players.
303 Another objective of this research was to determine the degree of adherence to the MD of
304 handball players. In this line, the findings that were found indicated that the athletes have a
305 medium and good level of adherence to the MD (47.4% and 42.1%, respectively). These findings
306 are similar to those found in several studies, where it was also described that the predominant
307 degrees of adherence were medium or good (Vaquero-Cristóbal et al., 2018; Manzano-Carrasco

308 et al., 2020a; Martínez-Rodríguez et al., 2021). Along these lines, Manzano-Carrasco et al.,
309 2020a evaluated athletes of both sexes, and found that 57.6% of men and 59.8% of women had a
310 medium level of adherence. Martínez-Rodríguez et al., 2021, who evaluated both male and
311 female beach handball players, found that 66.0% of men and 76.0% of women also had a
312 medium level of adherence. Vaquero-Cristobal et al., 2018, evaluated elite cadet male canoeists,
313 and found that more than half of the sample had a good degree of adherence to the MD. All of
314 these results are similar to those found in the AdolesHealth study (Galan-Lopez et al., 2019),
315 which evaluated 1717 adolescents of both sexes, from different European cities and schools, and
316 which found that 54.92% had an average adherence to the Mediterranean diet. However, that the
317 dietary pattern of young athletes is the same as the general adolescent population does not mean
318 that it is optimal, as athletes have different requirements to maintain performance during the
319 competitive season (Thomas, Erdman & Burke, 2016). This is an important point for future
320 research.
321 On the other hand, and despite the fact that in our sample the predominant levels of adherence
322 were good and medium, no significant differences were found in the distribution of the level of
323 MD adherence. Manzano-Carrasco et al., 2020b, after evaluating young soccer players, also
324 found no significant differences in the KIDMED questionnaire score. This could be due to the
325 fact that the MD is being substituted by foods characteristic of other cultures, mainly affecting
326 adolescents (Rubio-Árias et al., 2015). However, there is a lack of more research that delves
327 deeper into this. Another aspect to highlight is that the degree of adherence to the MD has not
328 been correlated with the results of physical tests, but with some anthropometric characteristics.
329 Vaquero-Cristobal et al., 2018 found no relationship between adherence to the MD and
330 anthropometric parameters of male canoeists. Martínez-Rodríguez et al., 2021 concluded that
331 having a good MD adherence is not enough for obtaining better results in the performance tests
332 in male and female beach handball players. It has been suggested that this could be due to the
333 homogeneity in the adherence to the MD shown by athletes (Vaquero-Cristóbal et al., 2018).
334 Even then, more research is still lacking, both in handball and in other sports, for an in-depth
335 analysis of a sufficient sample size, of whether having a good adherence to the MD or specific
336 eating habits influences performance and body composition or anthropometric characteristics.
337 The last objective of this research was to know if there was a relationship between
338 anthropometric characteristics and sports performance. Along this line, the findings indicate that
339 both FM percentage and MM are important variables that describe the variability of the results of
340 the physical tests. More specifically, a low percentage of FM, a good development of MM, or
341 both, improve the results of the physical tests. The findings found regarding FM are in agreement
342 with those found by Hermassi et al., 2021, who evaluated obese and non-obese young male
343 handball players, and concluded that the percentage of FM negatively affected speed, vertical
344 jump and aerobic capacity, three basic and necessary skills for a handball player. In another
345 study by Hermassi et al. (Hermassi, Laudner & Schwesig, 2019) conducted with young male
346 handball players, the authors found that, with the exception of speed, there was a negative
347 association between FM and the vertical jump, SJ and CMJ performance tests. However, in

348 another study by Hammami et al., 2019 they found that FM was not related to performance
349 measurements, with the exception of vertical and horizontal jumps. Moncef et al., 2012 also
350 found no correlations between body fat and the vertical jump, SJ and CMJ tests, nor with the
351 endurance capacity of the players. Molina-López et al., 2020, after evaluating young handball
352 players, concluded that MM analysis proved to be more useful than FM assessment in
353 determining performance. These differences could be due to the heterogeneity in the competitive
354 level of the handball players included in the studies, so future lines of research should analyze
355 the specific weight of FM and MM according to the level of the players.
356 Regarding the limitations of this study, the main one was the sample size. It should also be taken
357 into account that the KIDMED questionnaire does not report the amount of food ingested.
358 Furthermore, as the study was cross-sectional, no MD-based nutritional interventions, which
359 could have improved body composition and performance, could have been performed. As for
360 future research, this study should be replicated with women. Another interesting aspect would be
361 to be able to perform a nutritional intervention based on the MD and to evaluate whether players
362 improve their body composition and performance. In this way, it would be possible to analyze in
363 depth, whether having an excellent association with the MD is related to better performance.
364 As possible practical applications both for handball professionals (sports federations, clubs,
365 coaches, physical trainers, etc.) and for the players themselves, it should be noted that this study
366 shows that the plastic components of body composition (adiposity and muscle development)
367 influence the physical condition tests related to handball performance, so that performance in this
368 sport could be improved by modifying these components. In this way, the anthropometric
369 characteristics of the players should be monitored throughout the season in order to be able to
370 individualize the nutritional and training plans to the needs of each player in the search for the
371 optimization of sports performance (Martinez-Rodriguez et al., 2020; Ghobadi et al., 2013).
372 Another practical application of the present study is that taller players have a competitive
373 advantage in physical fitness tests related to handball performance. Because of the influence of
374 maturation on this parameter (Albaladejo-Saura et al., 2021), the selection of players with early
375 maturation during these ages could bring better short-term performance (Albaladejo-Saura et al.,
376 2022), although it is not clear that this is an advantage when the maturation process is completed
377 and the characteristics are equalized (Albaladejo-Saura et al., 2021). On the other hand, there is
378 no great awareness on the part of the players of the importance of having a healthy diet in the
379 search for the optimization of their sports performance, especially in the pubertal stage, so it
380 would be necessary to carry out informative programs from an early age to increase awareness
381 among athletes on this issue.
382
Conclusions
384 In conclusion, there are differences according to category in most of the kinanthropometric and
385 physical condition variables, but not in the level of adherence to the MD, highlighting that as the
386 players were from a category with an older age range, the anthropometric characteristics and the
387 results of the physical tests were better. In addition, most of the subjects had a medium and good

388   level of adherence to the MD, and very few players showed a poor adherence. However, this
389   level of adherence was not associated to the results of the physical tests. Nevertheless, a
390   relationship between anthropometric characteristics and sports performance was observed;
391   having a low percentage of FM, having a good development of MM, or both, improves the
392   results of the physical tests.
393

Acknowledgements

395   The authors would like to thank the clubs and coaches who made this study possible, as well as
396   the volunteer players who participated, for their collaboration. We would also like to thank the
397   researchers who helped in the measurement sessions of the Prevention of Sports Injuries group of
398   the Catholic University San Antonio of Murcia and the Nursing department, Food and Nutrition
399   Research Group (ALINUT) of the University of Alicante, without whom this research would not
400   have been possible. This study is part of the doctoral thesis of David Romero García.
401

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Descriptive data (mean ± standard deviation) and differences according to category, including main effects of the covariate age and its intercept.

1 Table 1. Descriptive data (mean ± standard deviation) and differences according to category, including main effects of the covariate age

2 and its intercept.

Variable	Category (Mean ± SD)				Category			Age			Category*age		
	Infant (n=35)	Cadet (n=46)	Junior (n=26)	Senior (n=26)	F	p	η^2_p	F	p	η^2_p	F	p	η^2_p
Body Mass (kg)	52.80 ± 12.15	61.94 ± 12.79	72.69 ± 11.08	77.11 ± 15.78	21.72	**0.000**	0.336	43.72	**0.000**	0.250	15.375	**0.000**	0.325
Height (m)	1.59 ± 0.10	1.72 ± 0.06	1.77 ± 0.06	1.75 ± 0.05	36.81	**0.000**	0.462	37.63	**0.000**	0.223	27.125	**0.000**	0.459
BMI (kg/m2)	20.53 ± 3.68	20.90 ± 3.54	23.05 ± 3.22	24.94 ± 4.24	9.424	**0.000**	0.180	21.958	**0.000**	0.144	6.530	**0.000**	0.169
FM (%)	21.44 ± 9.67	14.52 ± 7.04	15.07 ± 7.01	17.56 ± 9.34	5.250	**0.002**	0.109	1.287	0.259	0.100	4.013	**0.004**	0.111
∑3-skinfolds (mm)	46.79 ± 19.60	32.38 ± 17.88	33.06 ± 16.74	41.18 ± 26.15	4.259	**0.007**	0.090	0.266	0.607	0.002	3.196	**0.015**	0.091
MM (kg)	22.31 ± 4.86	26.74 ± 5.87	32.64 ± 4.79	34.68 ± 6.40	31.706	**0.000**	0.424	68.84	**0.000**	0.344	23.249	**0.000**	0.421
∑3-girths sum corrected (mm)	98.19 ± 10.82	105.21 ± 12.17	115.76 ± 8.97	118.89 ± 13.49	22.990	**0.000**	0.348	49.53	**0.000**	0.274	16.631	**0.000**	0.342
KM	7.40 ± 1.98	6.37 ± 2.21	6.92 ± 2.46	6.38 ± 2.15	1.773	0.156	0.040	0.328	0.568	0.003	1.446	0.223	0.043
MB Throw (m)	4.39 ± 0.99	6.26 ± 1.13	7.66 ± 1.24	7.60 ± 1.14	58.408	**0.000**	0.576	78.55	**0.000**	0.375	43.773	**0.000**	0.578
T-Half Test (s)	7.05 ± 0.71	6.55 ± 0.64	6.01 ± 0.53	6.45 ± 0.47	14.872	**0.000**	0.257	8.480	**0.004**	0.061	11.428	**0.000**	0.263
SJ (cm)	18.94 ± 6.16	25.45 ± 4.72	30.28 ± 4.97	24.82 ± 6.61	21.423	**0.000**	0.333	10.423	**0.002**	0.074	16.254	**0.000**	0.337
CMJ (cm)	20.85 ± 6.26	29.87 ± 5.20	34.77 ± 5.90	30.79 ± 6.43	31.790	**0.000**	0.425	22.293	**0.000**	0.145	23.978	**0.000**	0.428
Sprint (s)	4.76 ± 0.34	4.29 ± 0.32	4.09 ± 0.22	4.31 ± 0.36	25.748	**0.000**	0.375	9.563	**0.002**	0.068	20.999	**0.000**	0.396
YoYo distance (m)	757 ± 453	1142 ± 420	1083 ± 415	1091 ± 452	5.911	**0.001**	0.121	3.603	0.060	0.027	4.517	**0.002**	0.124
YoYo VO₂ max (mL/min/kg)	42.75 ± 3.80	45.99 ± 3.53	45.50 ± 3.49	45.56 ± 3.79	5.911	**0.001**	0.121	3.603	0.060	0.027	4.517	**0.002**	0.124

3 SD: standard deviation; BMI: Body Mass Index; FM: Fat mass; ∑3-skinfolds: Sum of 3-skinfolds; MM: Muscle mass; ∑3-girths sum corrected: Sum of corrected girths; KM:

4 Kidmed; MB: Medicine ball; SJ: Squad Jump; CMJ: Counter Movement Jump.

Post hoc comparison between categories with significant differences in ANCOVA analysis for kinanthropometric characteristics.

1 Table 2. Post hoc comparison between categories with significant differences in ANCOVA analysis for kinanthropometric

2 characteristics.

Variable	Group comparison		Model					
			Category			Category*age		
			Mean difference ± SD	p	95% CI	Mean difference ± SD	p	95% CI
Body mass (kg)	I	C	-9.14 ± 2.91	**0.012**	-16.93 to -1.34	-8.80 ± 3.17	**0.038**	-17.29 to -0.31
	I	J	-19.89 ± 3.36	**0.000**	-28.88 to -10.89	-18.99 ± 4.71	**0.001**	-31.64 to -6.35
	I	S	-24.31 ± 3.36	**0.000**	-33.30 to -15.31	-22.73 ± 6.72	**0.006**	-40.75 to -4.72
	C	J	-10.75 ± 3.18	**0.006**	-19.27 to -2.22	-10.19 ± 3.80	**0.050**	-20.38 to -0.00
	C	S	-15.17 ± 3.18	**0.000**	-23.69 to -6.65	-13.93 ± 5.58	0.083	-28.89 to 1.029
	J	S	-4.42 ± 3.59	1.000	-14.05 to 5.21	-3.740 ± 4.39	1.000	-15.53 to 8.05
Height (m)	I	C	-0.12 ± 0.02	**0.000**	-0.16 to -0.07	-0.12 ± 0.02	**0.000**	-0.16 to -0.07
	I	J	-0.17 ± 0.02	**0.000**	-0.23 to -0.12	-0.17 ± 0.03	**0.000**	-0.24 to -0.09
	I	S	-0.15 ± 0.02	**0.000**	-0.21 to -0.10	-0.14 ± 0.04	**0.001**	-0.24 to -0.04
	C	J	-0.06 ± 0.018	**0.009**	-0.11 to -0.10	-0.05 ± 0.02	0.079	-0.11 to 0.00
	C	S	-0.04 ± 0.08	0.223	-0.08 to -0.01	-0.03 ± 0.03	1.000	-0.11 to 0.06
	J	S	0.02 ± 0.02	1.000	-0.03 to 0.07	0.03 ± 0.02	1.000	-0.04 to 0.09
BMI (kg/m2)	I	C	-0.37 ± 0.83	1.000	-2.59 to 1.84	-0.29 ± 0.90	1.000	-2.69 to 2.14
	I	J	-2.52 ± 0.95	0.056	-5.08 to 0.04	-2.276 ± 1.34	0.554	-5.873 to 1.32
	I	S	-4.41 ± 0.95	**0.000**	-6.97 to -1.85	-2.276 ± 1.34	0.236	-9.11 to 1.14
	C	J	-2.15 ± 0.90	0.115	-4.57 to 0.28	-1.99 ± 1.08	0.404	-4.89 to 0.90
	C	S	-4.04 ± 0.90	**0.000**	-6.47 to - 1.61	-3.70 ± 1.59	0.128	-7.96 to 0.55
	J	S	-1.89 ± 1.02	0.400	-4.63 to 0.85	-1.71 ± 1.25	1.000	-5.01 to 1.65
FM (%)	I	C	6.92 ± 1.85	**0.002**	1.95 to 11.89	6.67 ± 2.02	**0.008**	1.25 to 12.08
	I	J	6.36 ± 2.14	**0.021**	0.63 to 12.10	5.69 ± 3.01	0.363	-2.37 to 13.76
	I	S	3.88 ± 2.14	0.433	-1.85 to 9.62	2.70 ± 4.29	1.000	-8.79 to 14.19
	C	J	-0.55 ± 2.03	1.000	-5.99 to 4.88	-0.93 ± 2.42	1.000	-7.47 to 5.53
	C	S	-3.04 ± 2.03	0.821	-8.47 to 2.40	-3.96 ± 3.56	1.000	-13.51 to 5.58
	J	S	-2.48 ± 2.29	1.000	-8.63 to 3.66	-2.99 ± 2.80	1.000	-10.51 to 4.52
∑3-skinfolds (mm)	I	C	14.51 ± 4.48	**0.009**	2.49 to 26.52	14.31 ± 4.89	**0.024**	1.21 to 27.41
	I	J	13.73 ± 5.17	0.054	-0.14 to 27.59	13.19 ± 7.27	0.433	-6.30 to 32.69
	I	S	5.61 ± 5.17	1.000	-8.25 to 19.48	4.67 ± 10.37	1.000	-23.11 to 32.45
	C	J	-0.78 ± 4.90	1.000	-13.92 to 12.36	-1.12 ± 5.86	1.000	-16.83 to 14.59
	C	S	-8.89 ± 4.90	0.432	-22.03 to 4.25	-9.64 ± 8.61	1.000	-32.71 to

								13.43
	J	S	-8.11 ± 5.54	0.875	-22.97 to 6.74	-8.52 ± 6.78	1.000	-26.70 to 9.66
MM (kg)	I	C	-4.43 ± 1.24	**0.003**	-7.76 to -1.01	-3.85 ± 1.35	**0.030**	-7.46 to -0.23
	I	J	-10.33 ± 1.43	**0.000**	-14.17 to -6.49	-8.76 ± 2.01	**0.000**	-14.14 to -3.39
	I	S	-12.37 ± 1.43	**0.000**	-16.21 to -8.53	-9.61 ± 2.86	**0.006**	-17.27 to -1.95
	C	J	-5.90 ± 1.36	**0.000**	-9.54 to -2.26	-4.92 ± 1.62	**0.017**	-9.25 to -0.59
	C	S	-7.93 ± 1.36	**0.000**	-11.58 to -4.30	-5.76 ± 2.37	0.099	-12.12 to 0.59
	J	S	-2.04 ± 1.53	1.000	-6.15 to 2.08	-0.84 ± 1.87	1.000	-5.86 to 4.17
∑3-girths corrected sum (mm)	I	C	-7.01 ± 2.47	**0.032**	-13.63 to -0.39	-6.26 ± 2.69	0.129	-13.47 to 0.95
	I	J	-17.56 ± 2.85	**0.000**	-25.20 to -9.92	-15.55 ± 4.00	**0.001**	-26.27 to -4.83
	I	S	-20.70 ± 2.85	**0.000**	-28.34 to -13.05	-17.15 ± 5.70	**0.019**	-32.44 to -1.87
	C	J	-10.55 ± 2.70	**0.001**	-17.79 to -3.30	-9.29 ± 3.22	**0.028**	-17.93 to -0.65
	C	S	-13.68 ± 2.70	**0.000**	-20.92 to -6.44	-10.89 ± 4.74	0.138	-23.59 to 1.79
	J	S	-3.15 ± 3-05	1.000	-11.32 to 5.05	-1.60 ± 3.73	1.000	-11.60 to 8.39

3 SD: standard deviation; BMI: Body Mass Index; FM: Fat mass; ∑3-skinfolds: Sum of 3-skinfolds; MM: Muscle mass; ∑3 corrected PR: Sum of corrected girths.

Post hoc comparison between categories with significant differences in the ANCOVA analysis for physical capacity results.

1   Table 3. Post hoc comparison between categories with significant differences in the ANCOVA analysis for physical capacity results.

Variable	Group comparison		Model					
			Category			Category*age		
			Mean difference ± SD	p	95% CI	Mean difference ± SD	p	95% CI
MB Throw (m)	I	C	-1.87 ± 0.25	**0.000**	-2.54 to -1.19	-1.74 ± 0.27	**0.000**	-2.47 to -1.01
	I	J	-3.26 ± 0.29	**0.000**	-4.04 to -2.49	-2.91 ± 0.40	**0.000**	-3.99 to -1.83
	I	S	-3.21 ± 0.29	**0.000**	-3.99 to -2.43	-2.59 ± 0.58	**0.000**	-4.14 to -1.05
	C	J	-1.39 ± 0.27	**0.000**	-2.13 to -0.66	-1.17 ± 0.33	**0.003**	-2.05 to -0.30
	C	S	-1.34 ± 0.27	**0.000**	-2.08 to -0.60	-0.85 ± 0.48	0.462	-2.14 to 0.43
	J	S	0.05 ± 0.31	1.000	-0.78 to 0.88	0.32 ± 0.38	1.000	-0.69 to 1.33
T-Half Test (s)	I	C	0.50 ± 0.14	**0.002**	0.13 to 0.87	0.57 ± 0.15	**0.001**	0.17 to 0.97
	I	J	1.04 ± 0.16	**0.000**	0.62 to 1.47	1.22 ± 0.22	**0.000**	0.63 to 1.81
	I	S	0.60 ± 0.16	**0.001**	0.18 to 1.02	0.91 ± 0.32	**0.026**	0.069 to 1.76
	C	J	0.54 ± 0.15	**0.003**	0.14 to 0.94	0.65 ± 0.18	**0.002**	0.17 to 1.13
	C	S	0.10 ± 0.15	1.000	-0.30 to 0.50	0.35 ± 0.26	1.000	-0.36 to 1.05
	J	S	-0.44 ± 0.17	0.063	-0.89 to 0.01	-0.30 ± 0.21	0.849	-0.86 to 0.25
SJ (cm)	I	C	-6.51 ± 1.25	**0.000**	-9.86 to -3.16	-6.54 ± 1.36	**0.000**	-10.19 to -2.89
	I	J	-11.34 ± 1.44	**0.000**	-15.20 to -7.47	-11.42 ± 2.03	**0.000**	-16.85 to -5.99
	I	S	-5.87 ± 1.44	**0.000**	-9.74 to -2.01	-6.01 ± 2.89	0.236	-13.76 to 1.73
	C	J	-4.83 ± 1.37	**0.003**	-8.49 to -1.18	-4.88 ± 1.63	**0.020**	-9.26 to -0.502
	C	S	0.64 ± 1.37	1.000	-3.02 to 4.29	0.52 ± 2.39	1.000	-5.90 to 6.95
	J	S	5.47 ± 1.54	**0.003**	1.33 to 9.60	5.40 ± 1.89	**0.030**	0.34 to 10.47
CMJ (cm)	I	C	-9.02 ± 1.32	**0.000**	-12.55 to -5.49	-9.04 ± 1.44	**0.000**	-12.89 to -5.19
	I	J	-13.92 ± 1.52	**0.000**	-17.99 to -9.85	-13.98 ± 2.14	**0.000**	-19.71 to -8.25
	I	S	-9.94 ± 1.52	**0.000**	-14.02 to -5.87	-10.04 ± 3.05	**0.008**	-18.21 to -1.87
	C	J	-4.90 ± 1.44	**0.005**	-8.76 to -1.04	-4.94 ± 1.72	**0.029**	-9.56 to -0.32
	C	S	-0.92 ± 1.44	1.000	-4.79 to 2.94	-1.00 ± 2.53	1.000	-7.78 to 5.78
	J	S	3.98 ± 1.63	0.096	-0.39 to 8.34	3.94 ± 1.99	0.303	-1.41 to 9.28
Sprint (s)	I	C	0.48 ± 0.07	**0.000**	0.28 to 0.66	0.53 ± 0.08	**0.000**	0.33 to 0.73
	I	J	0.67 ± 0.08	**0.000**	0.45 to 0.89	0.84 ± 0.11	**0.000**	0.53 to 1.14
	I	S	0.46 ± 0.08	**0.000**	0.24 to 0.68	0.75 ± 0.16	**0.000**	0.32 to 1.18
	C	J	0.20 ± 0.08	0.062	-0.01 to 0.41	0.31 ± 0.09	**0.006**	0.06 to 0.55
	C	S	-0.01 ± 0.08	1.000	-0.22 to 0.19	0.22 ± 0.13	0.134	-0.14 to 0.58
	J	S	-0.21 ± 0.09	0.108	-0.44 to 0.02	-0.08 ± 0.11	1.000	-0.37 to 0.20
YoYo (m)	I	C	-385 ± 97	**0.001**	-646 to -124	-457 ± 128	**0.003**	-802 to -113
	I	J	-326 ± 112	**0.026**	-627 to -25	-394 ± 188	0.228	-898 to 110
	I	S	-334 ± 112	**0.021**	-635 to -33	-404 ± 254	0.680	-1084 to 275
	C	J	59 ± 106	1.000	-227 to 344	63 ± 133	1.000	-294 to 421
	C	S	51 ± 106	1.000	-234 to 336	53 ± 190	1.000	-457 to 563

	J	S	8 ± 120	1.000	-330 to 315	-10 ± 132	1.000	-364 to 344
	I	C	-3.23 ± 0.82	**0.001**	-5.43 to -1.04	-3.84 ± 1.08	**0.003**	-6.74 to -0.95
	I	J	-2.74 ± 0.94	**0.026**	-5.27 to -0.21	-3.31 ± 1.58	0.228	-7.54 to 0.92
YoYo VO$_2$ max	I	S	-2.81 ± 0.94	**0.021**	-5.34 to -0.28	-3.40 ± 2.13	0.680	-9.10 to 2.31
(mL/min/kg)	C	J	0.49 ± 0.89	1.000	-1.90 to 2.89	0.53 ± 1.12	1.000	-2.47 to 3.53
	C	S	0.43 ± 0.89	1.000	-1.97 to 2.83	0.45 ± 1.60	1.000	-3.84 to 4.73
	J	S	-0.06 ± 1.01	1.000	-2.77 to 2.65	-0.08 ± 1.11	1.000	-3.06 to 2.89

2   SD: standard deviation; MB: Medicine ball; SJ: Squad Jump; CMJ: Counter Movement Jump.

Distribution (%) of the level of adherence to the Mediterranean diet according to category.

1   Table 4. Distribution (%) of the level of adherence to the Mediterranean diet according to category.

Adhesion	Infant (n=35)	Cadet (n=46)	Junior (n= 26)	Senior (n=26)	Total (n=133)	X^2 / p
Good (%)	54.3	32.6	50.0	34.6	42.1	$X^2 = 8.501$; $p = 0.204$
Average (%)	42.9	52.2	34.6	57.7	47.4	
Poor (%)	2.9	15.2	15.4	7.7	10.5	

Figure 1

Correlations between KIDMED score and kinanthropometric characteristics.

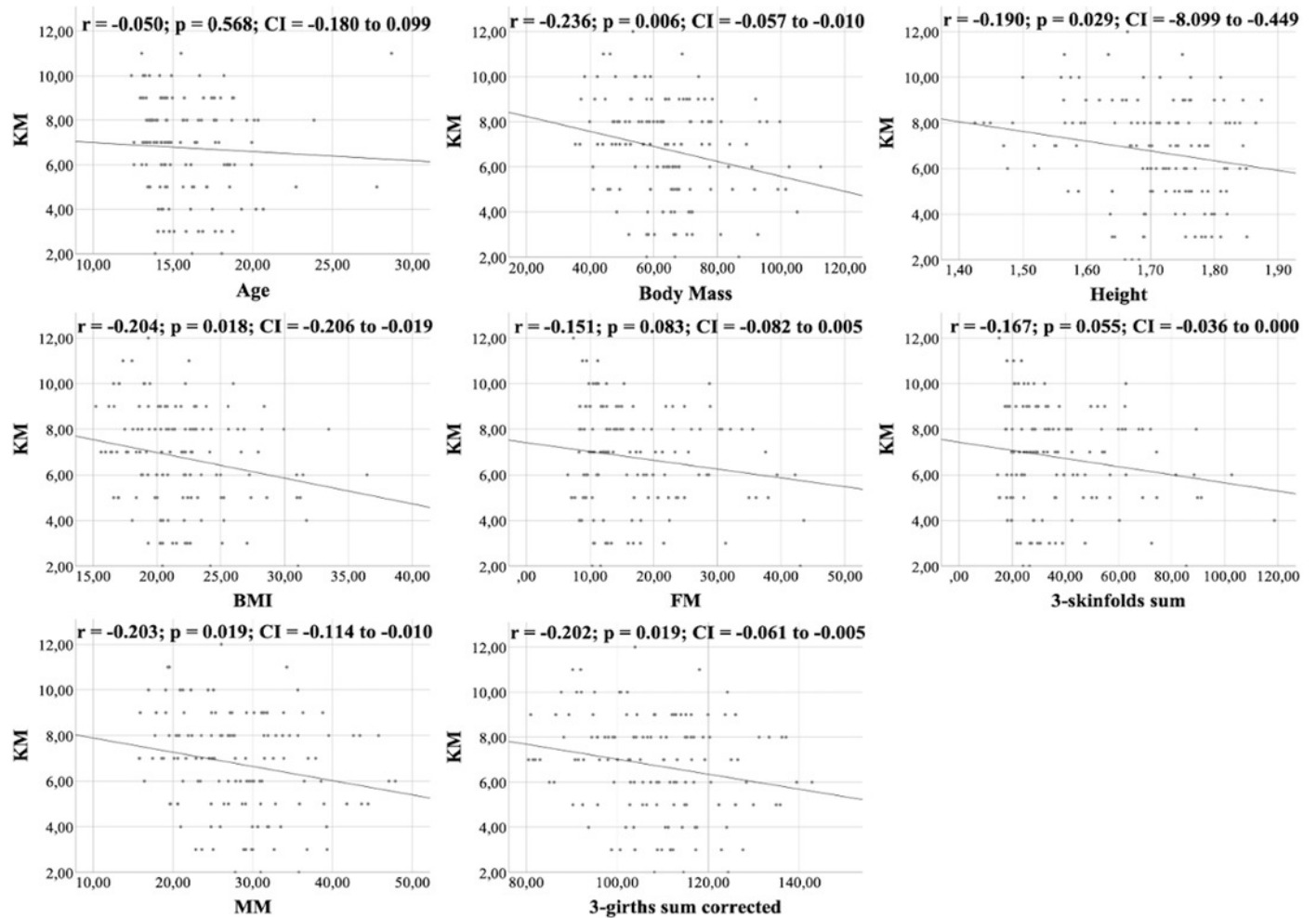



Figure 2

Correlations between medicine ball throwing, kinanthropometric characteristics and KIDMED score.

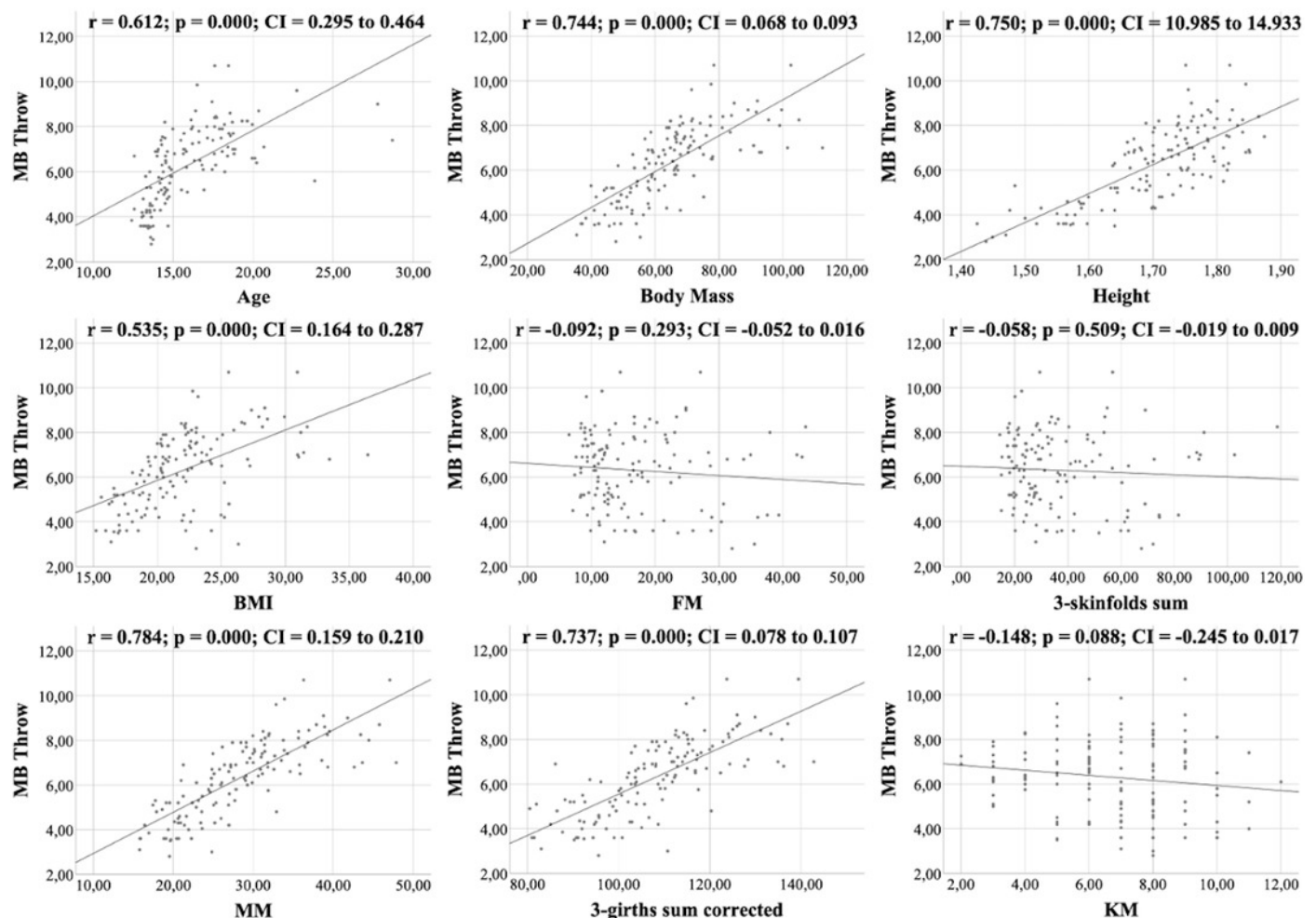



Figure 3

Correlations between T-Half test, kinanthropometric characteristics and KIDMED score.

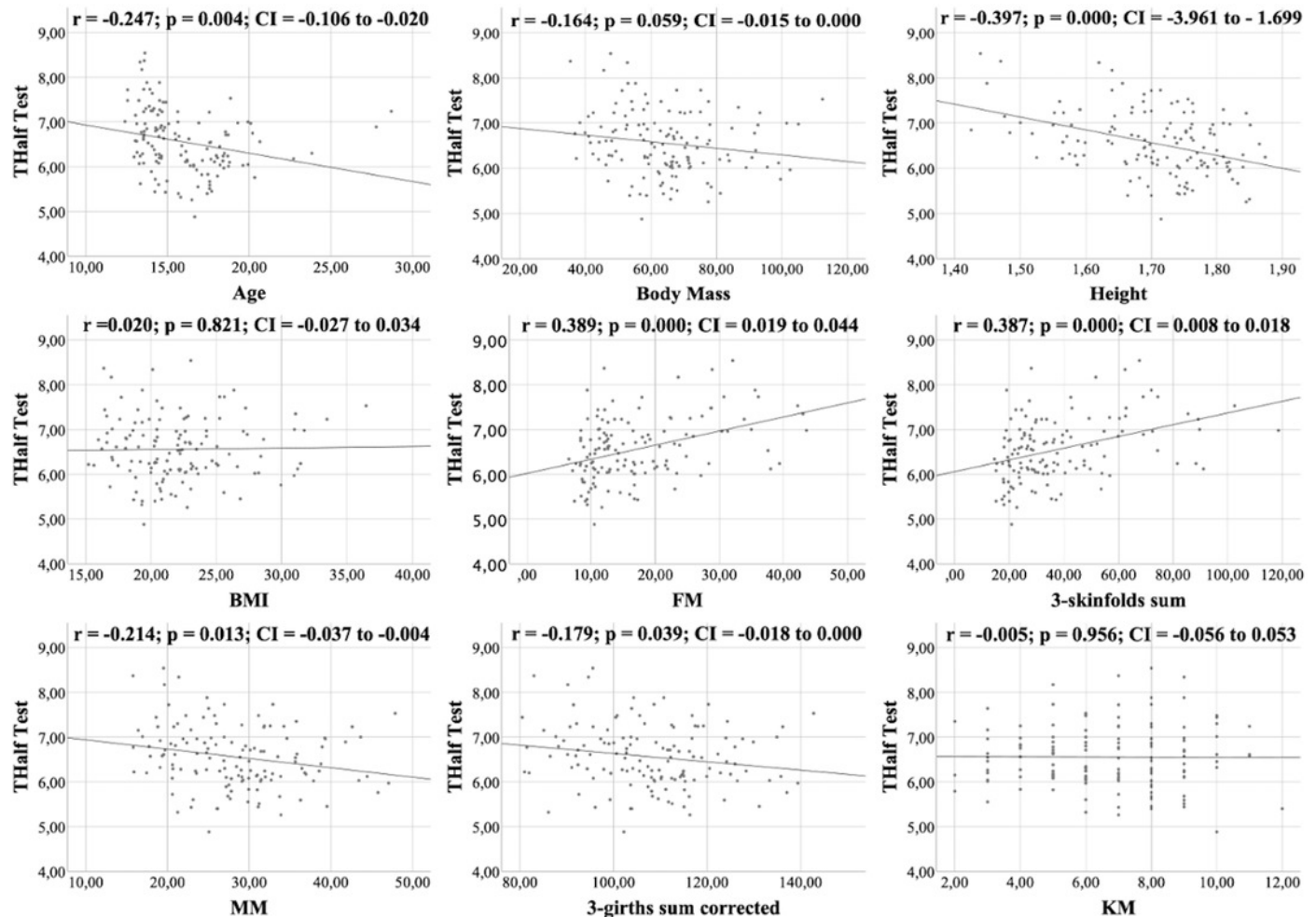



Figure 4

Correlations between the SJ test, kinanthropometric characteristics and the KIDMED score.

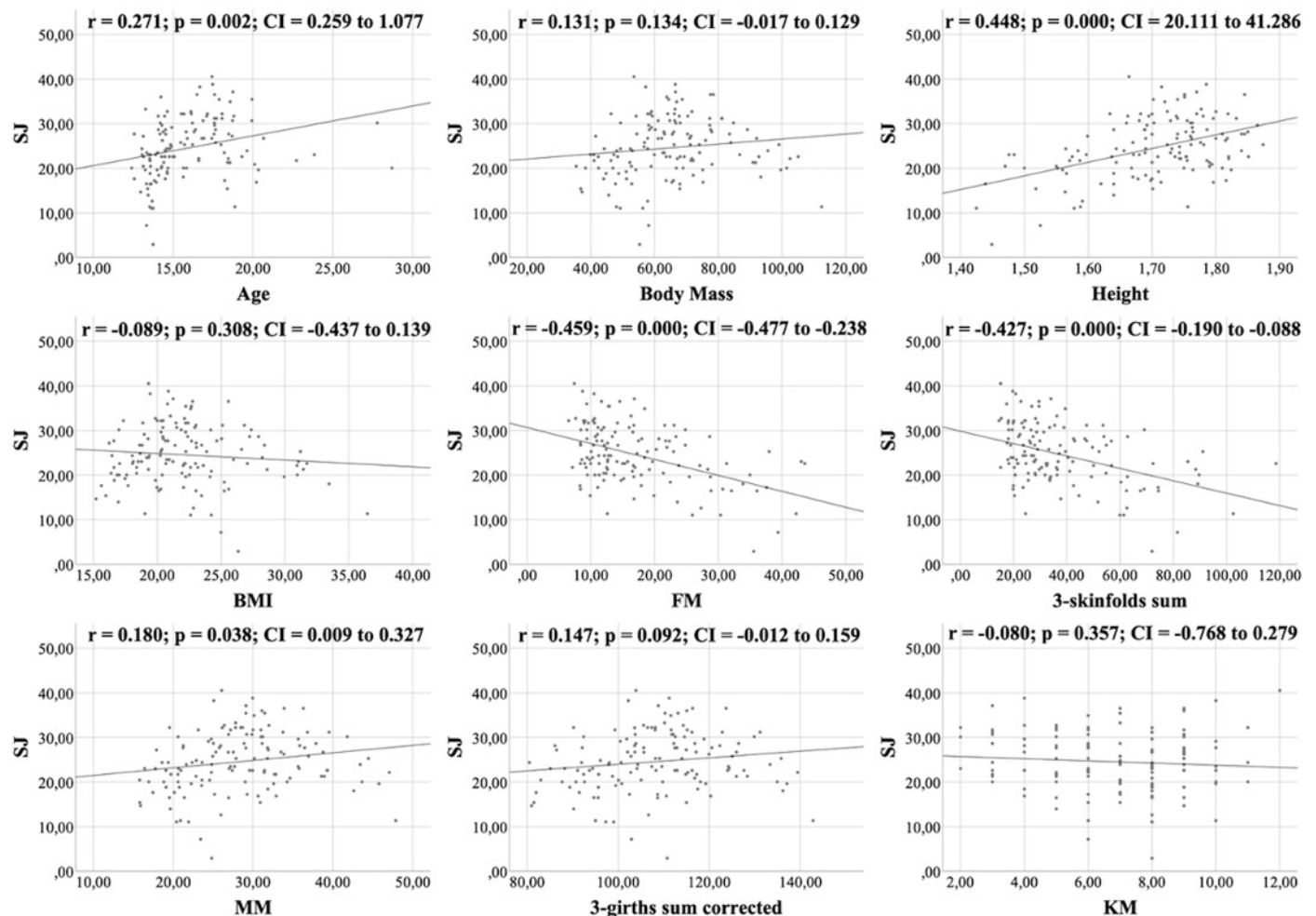



Figure 5

Correlations between the CMJ test, kinanthropometric characteristics and the KIDMED score.

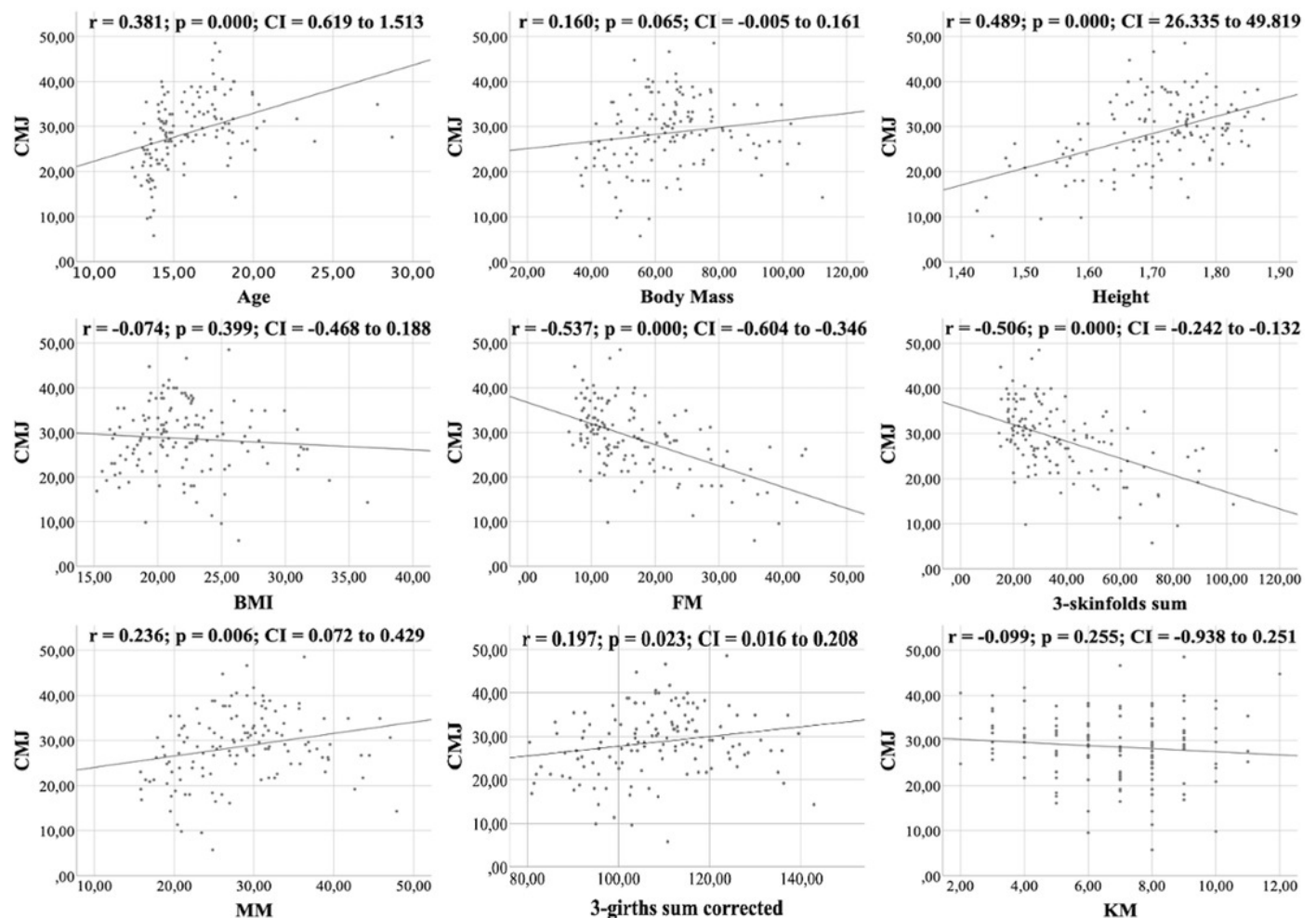



Figure 6

Correlations between sprint, kinanthropometric characteristics and KIDMED score.

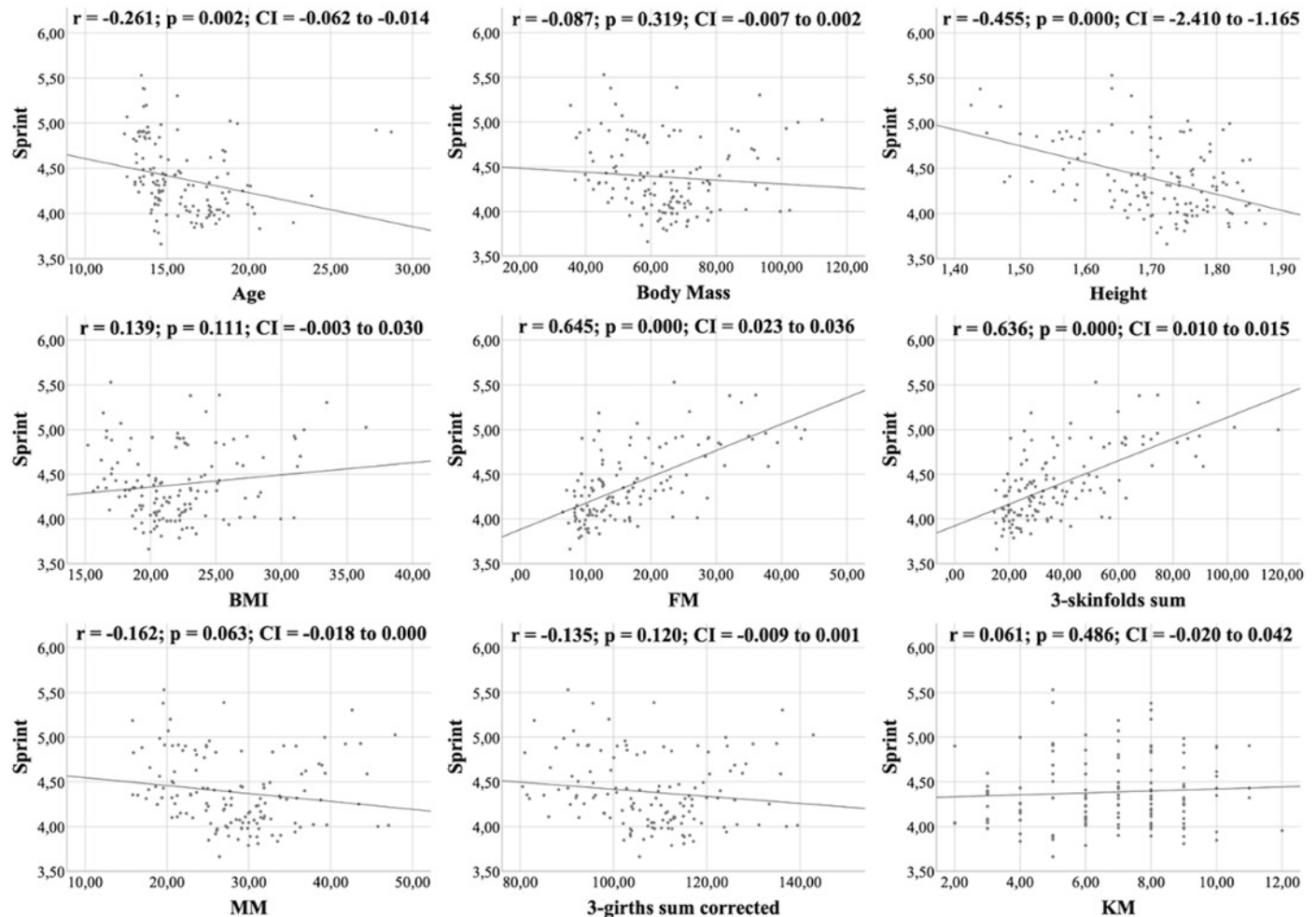



Figure 7

Correlations between YOYO test distance, kinanthropometric characteristics and KIDMED score.

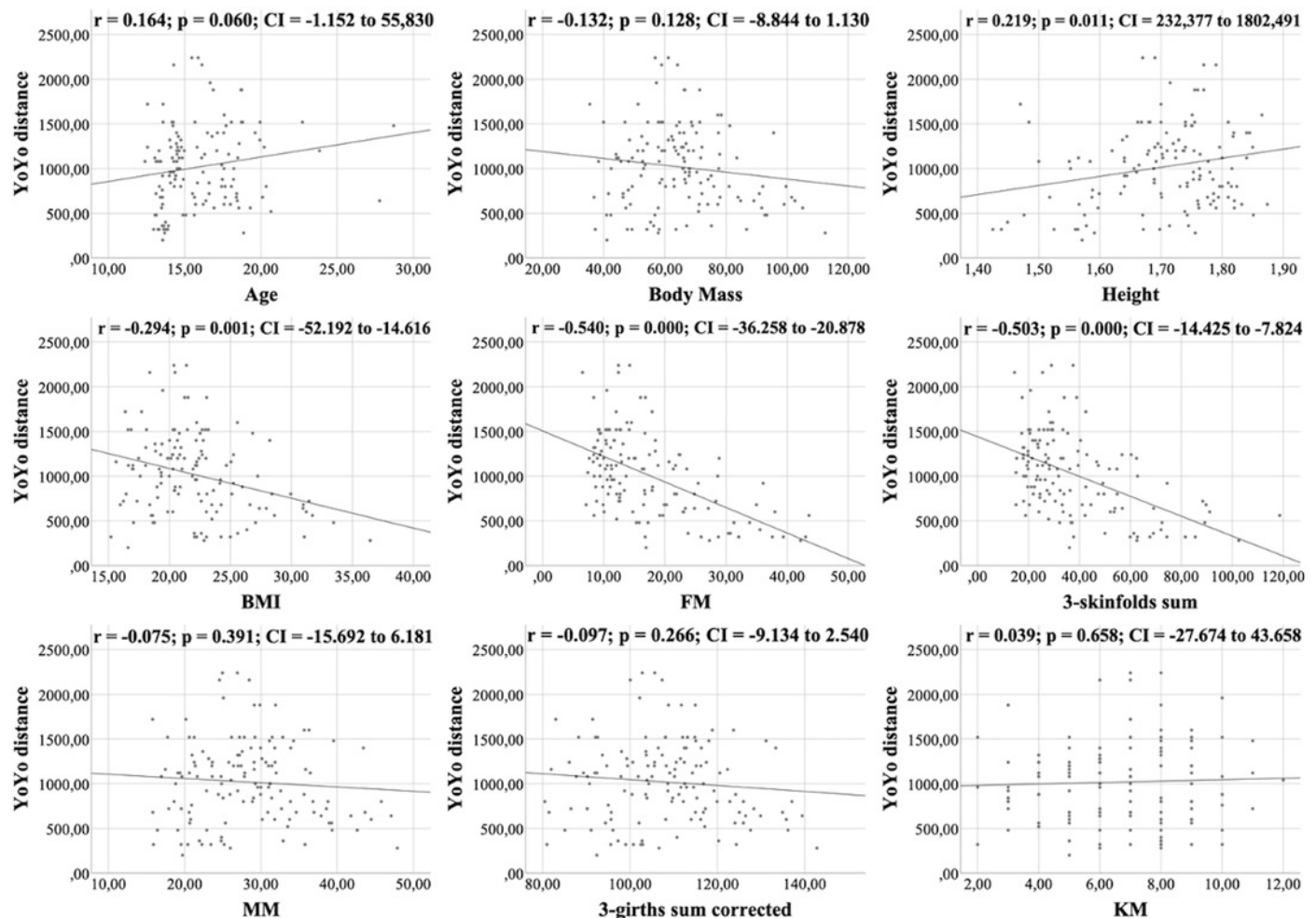
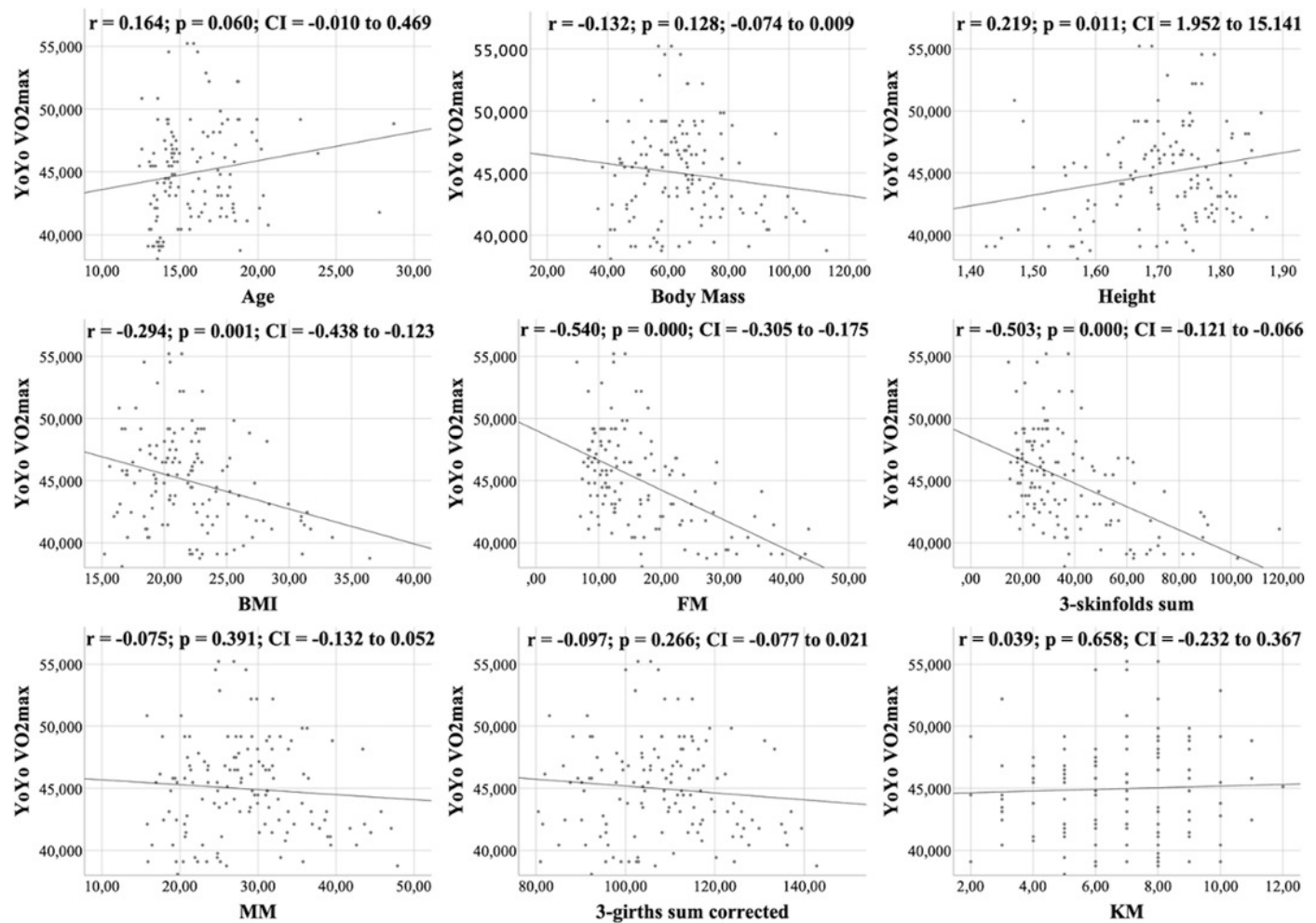



Figure 8

Correlations between YOYO test VO$_2$ max, kinanthropometric characteristics and KIDMED score.

Analysis and regression models of performance in the different physical capacities.

1   Table 5. Analysis and regression models of performance in the different physical capacities.

Variable	Analysis	R^2	p	Independent Variables Included	Standard Coefficient (ß)	Equation
KIDMED	Model 1	0.07	**0.006**	Body Mass	-0.24	KIDMED = 8.90 - 0.03*Body Mass
MB Throw	Model 1	0.61	**0.000**	MM	0.78	MB Throw = 1.09 + 0.18*MM
	Model 2	0.72	**0.000**	MM	1.37	MB Throw = 3.40 + 0.32*MM - 0.28*BMI
				BMI	-0.67	
T-Half Test	Model 1	0.16	**0.000**	Height	-0.40	T-Half Test = 11.38 - 2.83*Height
	Model 2	0.29	**0.000**	Height	-0.38	T-Half Test = 8.67 - 2.69*Height + 0.01*∑3-skinfolds
				∑3-skinfolds	0.37	
	Model 3	0.33	**0.000**	Height	-0.15	T-Half Test = 7.06 - 1.10*Height + 0.02*∑3-skinfolds - 0.03*MM
				∑3-skinfolds	0.51	
				MM	-0.32	
SJ	Model 1	0.21	**0.000**	FM	-0.46	SJ = 30.65 - 0.36*FM
	Model 2	0.38	**0.000**	FM	-0.42	SJ = -17.83 - 0.33*FM + 28.16*Height
				Height	0.41	
CMJ	Model 1	0.29	**0.000**	FM	-0.54	CMJ = 36.74 - 0.47*FM
	Model 2	0.51	**0.000**	FM	-0.72	CMJ = 24.42 - 0.64*FM + 0.53*MM
				MM	0.50	
Sprint	Model 1	0.42	**0.000**	FM	0.64	Sprint = 3.88 + 0.03*FM
	Model 2	0.57	**0.000**	FM	0.61	Sprint = 6.59 + 0.03*FM - 1.58*Height
			0.000	Height	-0.39	
YoYo distance	Model 1	0.29	**0.000**	FM	-0.54	YoYo distance = 1505 - 28.57*FM
	Model 2	0.32	**0.000**	FM	-0.52	YoYo distance = 123 - 27.77*FM + 803*Height
				Height	0.17	
YoYo VO$_2$ max	Model 1	0.29	**0.000**	FM	-0.54	YoYo VO$_2$ max = 49.05 – 0.24*FM
	Model 2	0.32	**0.000**	FM	-0.52	YoYo VO$_2$ max = 37.43 – 0.23*FM + 6.75*Height
				Height	0.17	

2   BMI: Body Mass Index; FM: Fat mass; ∑3-skinfolds: sum of 3-skinfolds; MM: Muscle mass; MB: Medicine ball; SJ: Squad Jump; CMJ: Counter Movement Jump.