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# Da Vinci's Vitruvian Man, Golden Ratio and Anthropometrics

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## Abstract

Objectives: Divine golden ratio (Phi = 1.618) observed in several human body parts such as, heart, dentition and upper limb tends to present homeostasis in anatomy and physiology. This cross sectional survey study investigates the relationship of golden ratio with BMI, GPA, gender and blood serotypes in Jordan.
Methods: Demographic features including GPA, body weight, lengths of some body parts and ABO/Rh blood groups were measured for 380 undergraduate students of matched age (19.14±0.76) and matched sex ratio. Navel-Foot/Height, Forearm-Hand/Armpit-hand and BMI were calculated. Golden ratio fitness was calculated based on phi and standard deviation of collected data.
Results showed significant gender differences in the means for all body lengths measured, GPA, BMI, and calculated ratios. Golden ratio fitted bodies students were 40.5% (Females > males). The overall prevalence of overweight and obesity was 15% (females < males), while 80% (females > males) have normal weight. Among the overweight and obese students 77.2% (44/57, females less than males) lies outside the golden ratio. The overall prevalence of GPA grades above good were 51.3% (females > males) and among them 47.7% (93/195, females > males) fit golden ratio while 67.2% of the good or below GPA grades (121/180, females < males) did not fit golden ratio. No significant difference between ABO-Rh system related to gender or golden ratio fitness. Statistically, a significant association was found between golden ratio and the three parameters BMI, GPA and gender.
Conclusions: Students who are golden ratio fitted bodies were more likely to have better BMI and GPA especially females.

## Keywords

Vitruvian man, Golden ratio, ABO serotypes, Rh factor, BMI, Anthropometrics.

## Introduction

Vitruvian man the iconic drawing by Leonardo da Vinci which represent the art and science of human body relationships and proportions as it translates Marcus Vitruvius Pollio work and ideas of golden ratio in human body (Figure 1). The embedded text in the iconic drawing of Leonardo Da Vinci's describes the relationship between different proportions of different human body lengths (Maloney and Fried, 2011; Gielo-Perczak, 2001). Gyorgi Doczi, an anatomist who suggests the golden ratio as the ideal proportion in human body lengths (Doczi, 1981).

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In mathematics, two quantities are in golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities (Livio, 2008). Golden ratio or Phi (φ) constant (1.618) observed in the universe suggests a role in balance and equilibrium as it were associated with esthetically and healthy bodies' (Jefferson, 2004). In human body, golden ratio or divine anthropometric was observed in DNA, heart, dentition and musculoskeletal mechanics as well as in upper limb measures which tends to present physical and biological homeostasis (Persaud and O'Leary, 2015; Yalta et al., 2016; Livio, 2008; Wang et al., 2017).

Golden ratio fitness represent human body parts in harmony and aesthetics as such, anatomy of human body represented by anthropometric measures has been investigated for potential link with golden ratio at different levels such as coronary blood vessels, genome, and hand skeleton (Persaud and O'Leary, 2015). Several factors influence human body anthropometrics (Anatomy) such as, age, gender, health status, and environment and consequently these factors have impact on the golden ratio (Katzmarzyk and Leonard, 1998).

The Phi (φ) constant (1.618) has been investigated for its association with many anthropometric measurements such as BMI and Height, in order to increase our understanding of development, growth, forensic medicine, physiotherapy, pathology, dentistry, medical imaging and many other applications in human life (WHO, 1995; Utkualp and Ercan, 2015; Livio, 2008; Saraswathi, 2019). A study suggest a golden ratio role in potential prediction of health problems based on anthropometric measures of the face (Saraswathi, 2019). However, a review of the evidence presented by investigations in different populations for the role of the Phi in anatomy and physiology were mixed (Iosa et al., 2018).

BMI is a worldwide adopted measure used to represent body fat composition which can be a predictor of health risk based on the distribution of body mass over a square of body height. BMI was classified into four grades; underweight (<18.5), normal (18.5 – 24.9), over weight (25 – 29.9) and obese (30) (WHO, 2004), however, its cut off points is different among different populations (Wildman et al., 2004; Misra, 2015). BMI value was observed to be influenced by sex, age and region (Perissinotto et al., 2002; Meeuwsen et al., 2010; Madanat et al., 2011; Madanat et al., 2007).

ABO and Rhesus (Rh) blood serotypes are key features in blood transfusion and are considered as a significant polymorphic and immunogenic system. ABO genotypes are polymorphs of three major alleles (A, B, O) which results in several phenotypes, while Rh system consisted of two structural genes; D and CcEe genes. Rh-positive individuals inherit one or two RHD genes, which result in expression of RhD antigen and are typed Rh-positive (Yamamoto et al., 1990; Avent and Reid, 2000).

ABO and Rh blood serotypes distributions exhibit variations based on population, time, and region (Liu et al., 2017; AlSuhaibani et al., 2015). In Jordan, A phenotype has the highest percentage while the AB phenotype has the lowest percentage (Hanania et al., 2007). Moreover ABO/Rh groups have been linked to several factors in humans such as, intelligence quotient (IQ) (Sarvottam et al., 2018), diseases (Franchini and Lippi, 2015) and behavior (Tsuchimine et al., 2015). For example, A-antigen containing groups were associated with higher levels of BMI, LDL, VLDL, triglycerides, cholesterol and blood pressure compared with other blood groups of patients with hypertension (Arora et al., 2018). Males with O blood group has a higher bone density than other blood groups (Davidson et al., 1990). Additionally, variations between

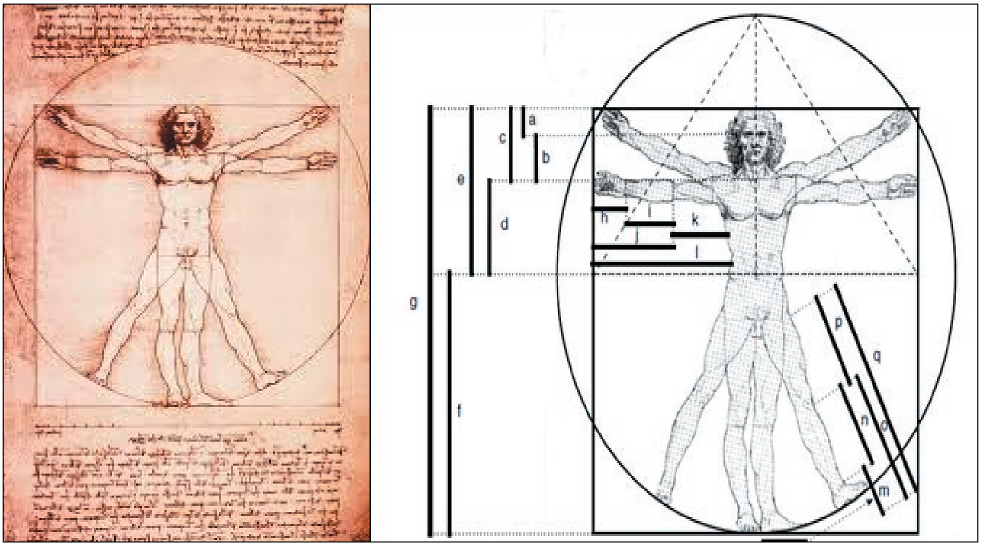


**Figure 1.** Leonardo da Vinci's drawing of Vitruvian man and body dimensions (Gielo-Perczak, 2001).

ABO groups was reported regarding bone density using lumbar and femoral bone densitometries (Aghighi et al., 2017).

The main aim of this study is investigating the association between human body parameters; ABO blood group, Rh factor, body mass index (BMI), gender, grade point average (GPA) and the golden ratio described by the Vitruvian man proportions among Jordanian undergraduate students.

## Methodology

This cross sectional study had been approved by the Institutional Review Board (IRB) at The Hashemite University in March 2019. A sample consisted of 380 undergraduate students aged 18-20 years of both sexes were recruited from the Hashemite University in April-June 2019. Aims, objectives, techniques, risks and benefits were explained. Security and confidentiality of collected data were warranted. Participants were asked kindly to read and sign consent form. Demographic features as, age, sex, GPA and study year were collected using a short survey. Body dimensions of different body parts including upper and lower limbs were measured and used to calculate two ratios (Figure 1) described by Leonardo da Vinci in his Vitruvian man drawing; one is based on human height and the other was based on human width for comparisons (Table 1 and 3). Calculated ratios were further classified into golden or not golden ratios fitness using a range of golden phi (φ) (0.618) within one standard deviation (Gielo-Perczak, 2001) (Table 3). Body height and weight were measured using measuring tape and electronic scale to the nearest of 0.1cm and 0.1kg, respectively. Height was measured without shoes and students were standing in the standard anatomical position.

BMI (called BMI-H) was calculated using the traditional Adolphe Quetelet equation: BMI = Weight (Kg) / Height$^2$ (m$^2$). In this study a new formula for BMI index (called BMI-W) was proposed using a ratio of weight distributed over the Leonardo da Vinci square of Vitruvian man (i.e. height multiplied by open hand width) calculated using the formula: BMI= weight (Kg) / (Height*Width) (m$^2$). BMI for both calculated ratios (H and W) were classified into four grades; underweight (<18.5), normal (18.5 – 24.9), over weight (25 – 29.9) and obese (30 or more) (WHO, 2004). Blood serotypes (ABO and Rh) were determined using red blood cells agglutination test, finger-puncture blood samples were collected on slides and Anti sera-A, Anti sera-B, and anti-D antibodies were added.

Collected data for body-parts lengths and demographic features were summarized as means and standard deviations. Two ratios of the human body proportions described by Leonardo Da Vinci in his famous drawing the Vitruvian were calculated for all participants and summarized as means and standard deviations (Gielo-Perczak, 2001) (Table 1). The two calculated ratios, one is based on human height and the other based on human width, were classified either golden or not golden ratios; a ratio that falls within the range of phi (φ) constant (0.618) ± 1 standard deviation of the corresponding calculated ratio were considered fitting the golden ratio (Gielo-Perczak, 2001). Ratios calculated:

1- Navel-Foot length / Head-Foot length (based on height)
2- Forearm-Hand length / Armpit-Hand length (based on width).

In addition, some of the ratios stated by Da Vinci in his Vitruvian man drawing were also calculated (Table 3):

“The greatest width of the shoulders contains in itself the fourth part of the man. Elbow to the tip of the hand will be the fifth part of a man. Elbow to the angle of the armpit will be the eighth part of the man. The whole hand will be the tenth part of the man.”

### Statistical Analysis

Statistical analysis of collected data were done using Microsoft Excel and SPSS statistical package version 21. Data collected were expressed as means and standard deviations (SD). Descriptive and inferential statistics were used to answer the research questions. Groups were compared using parametric and nonparametric tests accordingly. Significant difference was set at a p-value less than 0.05.

## Results

### General features (Table 1)

A total of 380 students with a mean age of 19.14 ± 0.76 were participated, 51.6% (196/380) were females and 48.4% (184/380) were males. Anthropometric measures showed that males were taller, wider, and heavier than females. On the other hand, females have higher GPA, better golden ratio and lower BMI than males. Statistical analysis showed a significant difference between females and males students in the means of weight, height, open hand width, head-navel length, navel-foot length,

**Table 1.** Descriptive and Inferential Statistical Summary of Anthropometrics Measures, Demographic Feature and Golden Ratio Fitness Data (n=380).

| Anthropometric and Demographic Feature | Female (n=196) (Mean ± S.D) | Males (n=184) (Mean ± S.D) |
|---|---|---|
| Weight* | 58.30 ± 12.45 | 74.90 ± 14.75 |
| Height* | 160.48 ± 5.92 | 175.69 ± 6.54 |
| Open Hand Width* | 163.34 ± 6.78 | 180.88 ± 7.48 |
| Head Navel* | 63.79 ± 3.31 | 70.72 ± 3.46 |
| Navel Foot* | 96.69 ± 4.19 | 104.97 ± 4.80 |
| Hand* | 17.75 ± 0.92 | 19.59 ± 1.07 |
| Forearm* | 42.91 ± 2.31 | 45.23 ± 2.99 |
| Armpit* | 72.36 ± 3.46 | 79.10 ± 4.07 |
| Age§ | 19.08 ± .74 | 19.20 ± .78 |
| BMI-H* | 22.64 ± 4.62 | 24.24 ± 4.42 |
| BMI-W* | 22.22 ± 4.42 | 23.54 ± 4.24 |
| Navel-Foot/Height (Vertical)* | 0.603 ± 0.014 | 0.596 ± 0.014 |
| Forearm-Hand/Armpit-Hand (Horizontal)* | 0.593 ± 0.024 | 0.572 ± 0.029 |
| GPA& (Median) | 3 | 2 |

| Variable | | Female (n=196) (Frequency) | Males (n=184) (Frequency) |
|---|---|---|---|
| Golden Ratio Fitness& | Yes | 99 | 55 |
| | No | 97 | 129 |
| Rh Factor | Rh+ve | 175 | 163 |
| | Rh-ve | 21 | 21 |
| Blood Group# | A | 78 | 60 |
| | B | 39 | 42 |
| | AB | 13 | 6 |
| | O | 66 | 76 |
| GPA#& | Satisfactory | 10 | 37 |
| | Good | 63 | 70 |
| | Very Good | 73 | 58 |
| | Excellent | 47 | 17 |
| BMI-H#& | Underweight | 16 | 3 |
| | Normal | 161 | 143 |
| | Overweight | 11 | 27 |
| | Obese | 8 | 11 |

*: T-test (2-tailed), $p < 0.05$.
§: Mann-Whitney test (2-tailed), $p = 0.103$.
&: Pearson Chi-Square test, p value $< 0.05$.
#: Dichotomies grouping.

hand length, forearm length, armpit length, BMI-H (Means or Category), BMI-W (Means or Category), and GPA (Median or Category), while there were no significant differences between males and females mean age (Table 1). Blood group O and A (37.3% and 36.3%) were the most prevalent and 88.9% of students were Rh+ve. ABO and Rh frequency distributions showed no significant difference between females and males statistically (Table 1). Interestingly, results showed that only 23 students out of the 380 students have their height equal to their open hand width while the majority of students have higher width than height (295/380).

The overall prevalence of golden ratio among all students was 40.5 % (154/380) (99/196 females and 55/184 males). Data showed that males who did not fit the golden ratio were 70.1% of all males and 49.5% of all females did not fit golden ratio (Table 1). Comparing frequency distribution of female and male students based on golden ratio fitness revealed a significant differences (Pearson Chi-Square (F/M); p = 0.001, OR = 2.39, 95% CI: 1.57– 3.65). Females were more likely to fit golden ratio than males (OR 2.39).

## BMI distribution relative to golden ratio

Results showed that the mean value of BMI-W was significantly lower than the mean value of BMI-H (T-test, p = 0.001). This difference between both BMI means is caused by differences in the open hand width and height of a person as data showed that the mean height is significantly lower than the mean width (Table 1). Data showed that the mean value of students BMI-H or BMI-W who fit golden ratio were lower than students who did not fit golden ratio and statistically this difference was significant (T-test, p = 0.001). This means that golden ratio fitted bodies have better BMI (i.e. lower values) (Table 1).

Results revealed that females have higher percentage in underweight and normal weight category than males, while males have higher percentage in overweight and obese category than females. Statistically this gender differences in BMI was significant (Pearson Chi-Square test, $P = 0.001$)) (Table 1). This means that females have better BMI than males. In addition, frequency distribution of BMI-H, categorized as four levels, showed that among the Hashemite University students aged 19 years, the overall prevalence of overweight and obesity was 15% (10% and 5%, 57/380, 19 females and 38 males) and 85% (80% and 5%) for normal weight and underweight levels.

BMI-H levels were compared based on golden ratio and results support a significant difference (Pearson Chi-Square test (All BMI levels), $P = 0.019$ ($X^2$ (3, N = 380)) (Table 2). Moreover, BMI-H levels dichotomized as (≤Normal) and (>Normal) then compared according to golden ratio fitness and data showed that among the overweight and obese students (>Normal), 77.2% (44/57, 13 females and 31 males) of them lie outside the golden ratio while in the normal weight and underweight students (≤Normal), 56.3% (182/323, 84 females and 98 males) of them lie outside the golden ratio range. Statistically this difference was significant (Pearson Chi-Square (≤Normal/>Normal); p = 0.003, OR = 2.62, 95% CI: 1.36– 5.06). Students who have ≤Normal BMI were more likely to fit golden ratio than students who have BMI >Normal (OR 2.62) (Table 2).

In summary, percentage of golden ratio fitted bodies were higher in normal weight females but not males. Whereas, the percentage of non-golden ratio fitted

**Table 2.** Summary and association between some body parameters and golden ratio (n=380).

| Variable | | Golden ratio fitness (Frequency) | |
|---|---|---|---|
| | | Yes (n=154) | No (n=226) |
| Gender* | Female | 99 | 97 |
| | Male | 55 | 129 |
| Rh Factor | Rh+ve | 142 | 196 |
| | Rh-ve | 12 | 30 |
| Blood Group# | A | 57 | 81 |
| | B | 28 | 53 |
| | AB | 11 | 8 |
| | O | 58 | 84 |
| GPA#* | Satisfactory | 13 | 34 |
| | Good | 46 | 87 |
| | Very Good | 60 | 71 |
| | Excellent | 33 | 31 |
| BMI-H§ | Mean | 22.41 | 24.09 |
| BMI-W§ | Mean | 21.78 | 23.59 |
| BMI-H#* | Underweight | 10 | 9 |
| | Normal | 131 | 173 |
| | Overweight | 10 | 28 |
| | Obese | 3 | 16 |

§: T-test, p value < 0.05
*: Pearson Chi-Square test, p value < 0.05
#: Dichotomies grouping

bodies were higher in obese and overweight females and males (Table 1). Females have a better BMI grades and higher golden ratio percentage than males.

### ABO and Rh blood groups distribution relative to golden ratio fitness

In blood types A, B, O, Rh+ve and Rh-ve, the percentage of non-golden ratio fitted bodies was higher than golden ratio fitted bodies, while in AB blood group, the golden ratio fitness percentage was higher. Comparing frequency of blood groups; ABO and Rh for golden ratio fitness showed no significant differences (Pearson Chi-Square test, $P = 0.064$ ($X^2$ (3, N = 380)) (Table 2). Moreover, ABO blood groups were categorized as a dichotomous variable (i.e. A and Not A) and were tested for association with golden ratio fitness and results showed no significant association for all dichotomized blood groups (ABO and Rh) (Pearson Chi-Square test for all, $P > 0.05$, ($X^2$ (3, N = 380)).

**Table 3.** Comparisons of Leonardo da Vinci's Theoretical Ratios and recorded ratios.

| # | Ratio | Leonardo da Vinci's Golden Ratio Mean ± S.D | Leonardo da Vinci's Recorded Ratio Mean ± S.D |
|---|---|---|---|
| 1. | Hand/Head – Foot | 0.100 | 0.111 ± 0.01 |
| 2. | Elbow – Hand/Head – Foot | 0.200 | 0.262 ± 0.01 |
| 3. | Shoulder – shoulder/Head – Foot | 0.250 | 0.123 ± 0.03 |
| 4. | Navel-Foot / Head-Foot | 0.618 | 0.600 ± 0.014 |
| 5. | Forearm-Hand / Armpit-Hand | 0.618 | 0.583 ± 0.029 |

### GPA distribution relative to golden ratio fitness

Results showed that females (120/375) have higher GPA grades than males (75/375) and statistical analysis demonstrates significant gender difference in favor of females (Pearson Chi-Square; p = 0.001, ($X^2$ (3, N = 380)) (Table 1). GPA grades were categorized as a dichotomous variable into above good (i.e. very good and excellent) and good (i.e. good and satisfactory) and were tested for association with golden ratio fitness and results showed that 24.8% (93/375) of all students have above good GPA grades and fit golden ratio while 15.7% (59/375) of all students have good GPA grades and fit golden ratio (Table 2). Statistically a significant association was present (Pearson Chi-Square (good/above good); p = 0.004, OR = 1.87, 95% CI: 1.23– 2.84) (Table 2). High GPA grades were more likely to fit golden ratio than low grades (OR 1.87). Moreover, comparing Leonardo da Vinci's Theoretical Ratios for human body in his drawings of Vitruvian man and recorded ratios for students showed similar values except for the Shoulder – Shoulder/Head – Foot ratio (Table 3).

## Discussions

### Main Findings

Results of this study gives insight about human body anthropometric data, weight, BMI GPA and ABO blood groups of similar age students and their association with the golden ratio or gender. Results confirmed gender differences in human body anthropometric data, BMI, GPA, and consequently calculated ratios. In addition, findings revealed that students who are golden ratio fitted bodies were more likely to have better BMI and GPA especially females. Also, findings showed that gender or golden ratio fitness has no association with ABO or Rh blood groups.

### BMI, Gender and Golden Ratio

Golden ratio fitness has been investigated for potential link with different human body levels such as coronary blood vessels, genome, and hand skeleton (Persaud and O'Leary, 2015). In this study females have golden ratio more than males. Several factors such as, age, gender, health status, and environment influence human body anthropometrics and consequently these factors have impact on the golden ratio (Katzmarzyk and Leonard, 1998). Gender differences in bone length development were reported which could impact the calculations of golden ratios and BMI as both were dependent on body lengths (Clark et al., 2007).

BMI has been shown to differ according to age, gender, ethnic group, lifestyle, health, and genetic variations (Mokdad et al., 2003; Williams et al., 2015; Nuttall, 2015), for example, obesity was associated with females in ELSA-Brazil study (Pinto et al., 2018) and a study in Jordan reported that women were more obese than men at the age of 25 or above (Khader et al., 2008) while another study in Jordan reported that obesity were more in males at age 14-16 (Abu Baker and Daradkeh, (2010)). This study revealed that males were more obese than females at the age of 20. These gender variations in results may be related to differences in the age of the sample selected.

BMI cut off points is different among different populations (Wildman et al., 2004, Misra, 2015). BMI grades used in this study were based on the world health organization classification (WHO) which belong to Asians (WHO, 2004; Perissinotto et al., 2002). Males and females of different ages showed differences in BMI – body fat composition (Meeuwsen et al., 2010) and this was supported by our results. BMI standard values were reported to be influenced by age, sex, and geography (Perissinotto et al., 2002) and similar conclusions were reported in Jordan (Madanat et al., 2011, Madanat et al., 2007). In this study, geography, age were controlled as Jordanian students of similar age and equal gender ratio were participated, and results confirm gender differences in BMI in favour of females (lower BMI) (Table 1). Additionally, gender variations in body lengths is reflected on the calculations of BMI as supported by the results of this study which might be explained by reported sex differences in bone length development in several populations (Clark et al., 2007).

## Proposed new BMI Formula

BMI is one of the indices that can be used to diagnose obesity, however, this ability is not fully precise and researchers recommend using new indices to predict BMI risk levels such as body fat percentage BF%, skinfold thickness and waist to hip ratio (WHR) (Romero-Corral et al., 2008; Ortega et al., 2016; Adab et al., 2018; Hall and Barwell, 2015). Based on our results that showed significant differences between body width and height we recommend the use of a BMI formula based on weight/height*width instead of the traditional BMI that based on weight/height*height which could be more accurately estimate of body weight distribution in the body. This new formula result in a lower new BMI-H*W than old BMI-H*H (Table 2).

## Vitruvian Man

The Da Vinci drawing was for a man and called "Vitruvian man" which raise a question of what about woman is there a "Vitruvian woman". Our results showed that the majority of students of both gender have higher body width than height (295/380) and this contrary to the Vitruvian man drawing which hypothesized equal height and width and only 23 of the 380 students (10F and 13M) have their height and width equal. Of those 23 Vitruvians 16 students have normal BMI and 5 students fit the golden ratio. Researchers demonstrates gender difference in body lengths which is supported by the results of this study (Oranges et al., 2016). A Turkish study found that nearly one third of the sample have matched Da Vinci proportions in his Vitruvian man circle and square (Yılmaz et al., 2005).

### GPA, Gender and Golden Ratio

Academic performance has been reported to differ according to gender in turkey (Dayioğlu and Türüt-Aşik, 2007) which is comparable with our results and another study in Pakistan were females have better academic performance than males (Arshad et al., 2015). Gender and ethnicity differences in GPA was also reported in students in favour of females (Holmes and Slate, 2017). Moreover, academic performance was linked with anthropometrics such as BMI (Alswat et al., 2017; Taras and Potts-Datema, 2005; Asirvatham et al., 2019). For example, in Sri Lanka, normal weight BMI were associated with better GPA, however, the study sample was from different university colleges students at different year levels (Wehigaldeniya et al., 2017). Our study showed a gender difference in favour of females and support an association with the golden ratio as an anthropometric measure. Higher grades were also associated with golden ratio fitness, GPA scores in university students were linked to body anthropometrics (Deliens et al., 2013). Another study link academic performance with physically active persons (Santana et al., 2017) and the general health status (Shaw et al., 2015). Moreover, using a large sample size and applying mendelian randomization was able to support a link with academic performance (Tyrrell et al., 2016).

### ABO, Rh, Gender and Golden Ratio

This study revealed no significant association between (ABO and Rh serotypes) and golden ratio or gender. A previous study confirmed no associations between gender and the distribution of blood groups among medical students in Pakistan (Abbasi et al., 2018; Butt et al., 2018). Several studies suggested a relation between health and blood groups (Smith et al., 2018). For example, BMI and risk of hypertension were investigated in students and results showed that B blood group may has a role (Bhattacharyya et al., 2010; Chandra and Gupta, 2012). To the best of our knowledge there are no studies on the association between blood groups and golden ratios, however, association was performed with other body anthropometrics measures such as BMI which depends on weight and height. The distribution of ABO blood groups or Rhesus according to BMI showed no significant differences with BMI scores above normal (Smith et al., 2018). This is also confirmed by our results as no association was seen between blood groups and BMI-H (Pearson Chi-Square test, $P = 0.964$ and 0.064 ($X^2$ (3, N = 380)), weight (ANOVA test, $P > 0.05$), height (ANOVA test, $P > 0.05$) and open hand width (ANOVA test, $P > 0.05$). A recent study that relies on obesity indices such as, lean body mass (LBM) other than BMI reported significant difference in the distribution of ABO or Rh blood groups (Siddiqui et al., 2019) and this association was also reported by other studies (Suadicani et al., 2005; Eren and Çeçen, 2019). In a previous study no statistical difference were reported between blood groups and obesity although sample was small and 85% were females (Asafa et al., 2019).

## Conclusion

This cross-sectional research provides informative data regarding body dimensions and different body lengths proportions of Jordanian undergraduate students at their first and second year of study. It revealed that students who are golden ratio fitted bodies were more likely to have better BMI and GPA especially females. No association between golden ratio fitness and ABO or Rh blood groups.

## Acknowledgments and Conflict-of-interest statement

We thank the Medical Laboratory Sciences Department at the Faculty of Applied Health Sciences – The Hashemite University for supporting this study.

The authors declare no conflict of interest.

## Author Contributions

All authors have made substantial contributions to all of the following: (1) Conception and Design of the study (All authors), (2) Acquisition of data (Khaldun M. Jacoub and Samya A. Omoush), (3) Analysis and Interpretation of data (Jihad A. M. Alzyoud and Abd Al-Rahman S. Al-Shudiefat), (4) Drafting the article and Revising it critically (All authors) (5) Final approval of the version to be submitted (All authors).

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