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Vertical facial disproportions in children with Class III malocclusion

Вертикалне фацијалне диспропорције код деце са III скелетном класом

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SUMMARY

Introduction/Objective Class III malocclusion is a sagital intermaxillar disproportion with dominant presence of mandible. Apart from primar sagital, anomalies in vertical face dimension can also be present. The aim of this study is to evaluate vertical facial disproportions in the sceletal Class III malocclusion in stage of mixed dentition, in order to better plan its early therapy.

Methods In total 100 children were randomly selected and divided according to cephalometric analyes in the two equal groups: group 1 (experimental group)– sceletal Class III malocclusion (n=50) and group 2 (control group)- sceletal Class I (n=50). The groups were further divided into three subgruops according to the age and gender of the children. Vertical craniofacial proportions were measured by anterior (upper, lower and total) and posterior facial height and their proportion. The values were statistically analysed ($p \leq 0.05$).

Results Upper anterior, lower anterior, total anterior and posterior facial height, proportion between lower and total anterior facial height, and proportion of posterior to total anterior facial height did not have a significant difference among children with Class I and Class III malocclusions. Upper anterior facial height proportional to total anterior facial height was statistically significant greater in experimental group when compared to control. Significant gender dimorphism was noted among the same subgroups.

Conclusion Vertical craniofacial proportions in children with Class III malocclusion in stage of mixed dentition was not significantly changed. This finding leaves room for the successful application of early, individually planned orthodontic therapy.

Keywords: Clas III malocclusion; mixed dentition; facial height; gender dimorphism

САЖЕТАК

Увод/Циљ Малоклузија III скелетне класе је сагитални међувилични несклад са доминантним изгледом доње вилице. Уз примарне сагиталне, могу постојати и неправилности у вертикалној димензији лица. Циљ ове студије је процена вертикалних диспропорција лица код малоклузије III скелетне класе у доба мешовите дентиције, ради успешнијег планирања њене ране терапије.

Методе Укупно 100 деце одабраних случајним избором, подељени су према резултатима кефалометријске анализе у две једнаке групе: 1.група (експериментална) – са III скелетном класом (*n* = 50) и 2. група (контролна) – са I скелетном класом (*n* = 50). Групе су даље подељене у по три подгрупе према старости и полу. Вертикалне краниофацијалне пропорције процењивана одређиване су мерењем предње (горње, доње и укупне) и задње висине лица и њихових пропорција. Вредности су статистички обрађене ($p \leq 0.05$).

Резултати Горња предња, доња предња, укупна предња и задња висина лица, пропорција између доње и тоталне предње висине лица, као и пропорција између задње и предње укупне висине лица, нису се статистички значајно разликовале код деца са I и III скелетном класом. Горња предња висина лица пропорционално укупној предњој висини лица, статистички је значајно већа у експерименталној групи у односу на контролну. Утврђена је значајност родне разлике између истих старосних подгрупа.

Закључак Вертикалне краниофацијалне пропорције код деце са III скелетном класом у доба мешовите дентиције нису битно нарушене. Овакав налаз оставља простора за успешну примену ране, индивидуално планиране ортодонтске терапије.

Кључне речи: малоклузија III скелетне класе; мешовита дентиција; висина лица; родна разлика

INTRODUCTION

Class III malocclusion is definied as a heterogenous group of sceletal and dental anomalies of intermaxillary relationships, mainly in sagital dimension. Combination of this anomalies in facial morphology is resulting in dominant presence of mandibla. Beside primar sagital intermaxillar dysharmony, anomalies in vertical dimension could also be present, causing specific „long face“ or „short face“ morphology. Vertical facial type, defined by viscerocranium type and direction of rotation to cranial base, is the most responsible (apart from genetic) for Class III malocclusion.

Vertical facial height is directly depending on mutual relations of jaws' bones to cranial structures. Therefore, malocclusions are considered developmental anomalies that are result of specific development. That is the reason why they are having a full clinical apperarnce only when craniofacial growth is over.

Linear parameters for facial analysis varied according to age, gender, ethnic rase and other characteristics. That is the reason why proportions among linear parameters are having greater importance in practice.

The cephalometric analysis proposed by Johnson, which represents an addition to Wylie's analysis, suggested that the relationships in anterior facial height can be considered normal if upper segment of anterior facial height is 45% of total anterior height, and if lower is 55%.

Jarabak's, which is based on the Björk's cephalometric analysis suggested that relationship between anterior and posterior facial height should be 62-65% of anterior facial height. If that relationship is bigger than 65%, facial growth is determined by anterior rotation-convergent type of growth, which will probably lead to development of "short face" or deep bite. If the relationship is lower than 62%, it will cause a backward rotation-divergent type, leading to "long face" and open bite [1].

Estimation of facial height in Class III malocclusion is having a huge practical importance in early prediction of the therapy success. Hyperdivergent growth type, determined by lower values of this proportion („long face") is, according to many authors, considered as a bad prognostic sign in the therapy outcome [2]. This fact is very important when therapy plan for Class III maloclussiuon is made and should be considered mandatory (having on mind a complex combination of genetic and enviromental factors). Early therapy should be considered as „a focus" of orthodontic therapy. This can be the ideal time to eliminate bad habits, such as thumbsucking, mouth breathing, enlarged adenoid vegetation... Benefit of orthodontic prevention is wide, having in mind a potention to selfcorrect an open bite, malocclusion Class III, incisal overbite [3, 4]. Later, intrudion of the molars with miniimplants [5] showed satisfying results in the therapy of closing of open bite (better results obtained in adolescents than in adults, which is in accordance with previously published studies [6].

METHODS

This study included children with sceletal Class I and III, in stage of mixed dentition, aged 6-12 years, both gender, that have never undergone orthodontic treatment before. This study did not include children with congenital anomalies, clefts and hypodontia. To all participants, gnathometric analyses of the dental casts were done. Further, panoramic radiographs and lateral cephalometric radiograms (natural position of the head with lateral teeth in maximal intercuspidation) were analyzed. According to the cephalometric and gnathometric analyses, participants (*n*=100) were divided in two groups: first (experimental) group (*n*=50) included children with Class III malocclussion with negative OJ and ANB ≤ 0° (Figure 1). Second (control) group (*n*=50) included children with Class I with normal OJ and normal values of angles SNA=80-82°, SNB=78-80° and ANB=2-4° (Figure 1). On lateral cephalometric radiograms face length was determined by linear parameters such as upper anterior, lower anterior, total anterior and posterior facial height (NSna, SnaMe, NMe and SGo) and their proportion NSna/NMe, SnaMe/NMe, SGo/NMe (Figure 2).

Mean age of the participants in the experimental group was 8 years and 9 months, and in control group 9 years and 3 months. The participants from both groups were further divided in the subgroups according to the gender (F=25, M=25) and age:

a- subgroup; age: 6 years-7 years and 11 months,

b- subgroup; age: 8 years-9 years and 11 months, and

c- subgroup; age: 10-12 years (Figure 3, 4).

In order to detect significant differences between groups, Multiple comparisons and Brown-Forsythe test were used, and to access significant difference among patients related to gender and age, Mann-Whitney and Wilcoxon's tests were used. A 95% confidence level ($p<0.05$) was considered statistically significant, while a 99% confidence level was considered highly statistically significant.

RESULTS

Upper anterior facial height for the participants from the group 1 were 46-72 mm (mean height: 51.96 mm). These values were with no significant difference between genders in the same age subgroups ($p>0.05$). Upper anterior facial height for the participants from the group 2 were 47-58 mm (mean height: 52.02 mm). These values were with no significant difference between genders in the same age subgroups ($p>0.05$) and with no significant difference compared to group 1 ($p>0.05$).

Lower anterior facial height for the participants from the group 1 were 53-74 mm (mean height: 64.58 mm). These values were with no significant difference between genders in the same age subgroups ($p>0.05$). Lower anterior facial height for the participants from the group 2 were 56-76 mm (mean height: 64.92mm). These values were with no significant difference compared to group 1

(p>0.05). Statistical significance between gender was noted in middle (b) and the oldest (c) age subgroup (p≤0.01, p≤0.05).

Total anterior facial height for the participants from the group 1 were 103-131 mm (mean height: 116.69 mm). These values were with no significant difference between genders in the same age subgroups (p>0.05). Total anterior facial height for the participants from the group 2 were 105-132 mm (mean height: 116.94 mm). Statistical significance between gender was noted in middle (b) and the oldest (c) age subgroup (p≤0.05) and with no significant difference compared to group 1 (p>0.05).

Posterior facial height for the participants from the group 1 were 60-94 mm (mean height: 73.56 mm). Eventhough these values were of huge range; from 67 mm at female participants in the youngest (a) subgroup to 77.67 mm at male participants in the oldest (c) age subgroup, they were with no significant difference between genders in the same age subgroups (p>0.05). Posterior facial height for the participants from the group 2 were 59-92 mm (mean height: 73.08 mm). These values were with no significant difference compared to group 1 (p>0.05). Significance among genders was noted only in the middle (b) age subgroup (p≤0.05), where lowest value was 69.39 mm and highest value was 76.36 mm for males.

Proportion between upper and total anterior facial height for the participants in group 1 were in range 40.98 to 48.54 (mean value: 44.9). Significance among genders was noted only in the youngest (a) age subgroup (p≤0.01). Proportion between upper and total anterior facial height for the participants in group 2 were in range 40.68 to 50.88 (mean value: 44.50). These values were with no significant difference between genders in the same age subgroups (p>0.05), but were highly significant compared to the group 1 (p≤0.05).

Proportion between lower and total anterior facial height for the participants in group 1 were in range 51.46 to 63.93 (mean value: 55.54). Significance among gender was noted only in the youngest (a) age subgroup (p≤0.01). Proportion between upper and total anterior facial height for the participants in group 2 were in range 49.12 to 59.32 (mean value: 55.50). These values were with no significant difference between genders in the same age subgroups (p>0.05), and with no significant difference compared to group 1 (p>0.05).

Values for the proportion of posterior to anterior facial height in the group 1 were in range of 50.42 to 73.73 (mean value: 63.16). These values were with no significant difference between genders in the same age subgroups (p>0.05). Values for the proportion of posterior to anterior facial height in the group 2 were in range of 51.75 to 74.80 (mean value: 62.51). These values were with no significant difference between genders in the same age subgroups ($p>0.05$), and with no significant difference compared to group 1 ($p>0.05$).

DISCUSSION

Etiology of Class III malocclusions is multifactorial, which includes genetic, environmental factors, static and functional muscle factors and individual growth [3, 4]. Many studies investigated sagital, vertical and transversal changes during growth of the children with Class III malocclusion [7-9]. The facial growth pattern (anterior or posterior rotation) can lead to vertical craniofacial disproportions, i.e. deep or open bite, but it also affects the sagittal relationship between the jaws and can cause potential disproportions in that plane. Also, there are few studies that have investigated the relationship between position of the cervical vertebrae and the vertical craniofacial traits [10, 11]. Modern point of view states that development is related to presence of dimensional proportions among specific anatomic structures and change of these proportions during growth. Head bones during growth are making a bone mass, rotating and changing in all three dimensions [11]. At imbalanced growth, anterior rotation can dominate causing horizontal growth type with tendency of upgrowth of deep bite. Present combination of types of the facial bones growth together with growth of accompanied surrounding structures, affects type of the whole face, that can encourage or discourage Class III malocclusion and wide morphologic variation of it [12, 13].

Elis et al. compared patients with Class III malocclusion with open bite and pateints with Class III malocclusion without open bite [14], while Jacobson et al. defined subclassification of Class III malocclusion of two big groups according to vertical dimension of the face-divergent and convergent [15]. In order to define model of vertical growth of the face bones, that will determine their mutual relation to cranial structures, defining a vertical dimension of the face using angular and linear parameters.

The vertical dimension of the face is largely determined by the position of the mandible. SGnFH, NSGn and SGn are parameters that show the mandibular growth model. Their values can be significantly reduced in Class III malocclusions [16].

For the estimation of vertical facial height it is very important to determine vertical direction of maxilla to cranial structures [16-19]. Shuster et al. confirmed the importance of this parameter in children with malocclusion of the III class in assessing the need for future orthodontic-surgical therapy [20]. Analysis of angle indicator vertical intermaxillary relationships (B angle) in Syrian children with Class III malocclusion demonstrated statistically great value of this angle in comparison with Class I malocclusion [21], while Kerr et al. on Michigan children demonstrated statistically lower value of this angle in children with Class III malocclusion [22]. Contrary, Chang et al. did not find a difference in the value of this angle in Class III malocclusion children with mixed dentition when compared to Class I malocclusion [16]. Results of this study related to values of segmental anterior facial height (upper-NSna, lower-SnaMe and total-NMe) were not significantly different in children with Class I and III malocclusion (Figure 5-8). Chang et al. analysed these values in children with Class III malocclusion with mixed dentition and demonstrated presence of significantly smaller lower anterior facial height than in Class I malocclusion, while values of upper and total anterior facial height did not vary significantly [16].

In participants of different gender in the same age subgroups, statistically significant difference was demonstrated only for values of lower and total anterior facial height in middle and oldest control subgroup. This finding demonstrate that male children with normal sceletal relationship, from 8th year of age have lower and, consequently, total anterior facial height greater than female children. This results are in accordance with results obtained from Drevensek et al. [23], who demonstrated similar results on Slovenian children in stage of mixed dentition with good occlusion (estimated by Eismann method). Their study, like ours, demonstrated greater total anterior facial height in male children, but unlike our results, they did not show a difference among children with early and late mixed dentition.

Study by Wu et al. on 12-year old Chinese and Caucasian children with normal occlusion (by McNamara standards), demonstrated significant gender and ethnical determination of anterior facial height [24]. Further, the results also demonstrated significantly greater lower anterior facial height in male children in both ethnic groups. Longitudinal study on European children with Class I malocclusion, aged 6-18 years demonstrated significantly greater upper anterior facial heights in males after 14th year, and after 16th year lower, as well [25]. Similar study on children 10-14 y.o, that discussed the dynamic of longitudinal and transversal facial growth in that period, also indicated more intensive longitudinal and transversal growth in males than females, with peak growth 12-14 y.o. for males and 10-12 y.o. for females. Same study demonstrated greater intensity of longitudinal growth, when compared to transversal, in this period for both genders [26].

In our study, among children with Class III malocclusion in both gender in the same age podgroups, no statistical significance in anterior facial height had been observed. Inrestingly, results of Bacetti et al. on the Caucasian children with Class III malocclusion (aged 6-8 years) demonstrated that in 8 years old males lower anterior facial height was significantly longer (seen for the first time). This phenomenon will least until the age of 10 years, until when the lenght will equalized (11 and 12 years), and after 13th year and later, significantly higher lower and upper anterior facial height in males were observed [27].

Comparing children with Class I and Class III malocclusions, mean values of the posterior and anterior facial height were with no statistical significance. Difference in the values of the posterior facial height in both gender was significant just in the middle (b) age subgroup, wherein males had a significantly greater height of this parameter than females. This finding was in accordance with previously published studies [23], where children with Class III malocclusion were not with significant mean values of the posterior facial height among genders in the same age subgroups.

Upper facial height proportional to total anterior facial height (NSna/NMe) was statistically significant greater in experimental group when compared to control. Proportion between lower and total anterior facial height (Sna/NMe) and proportion of posterior to anterior facial height (SGo/NMe) did not have a significant difference among children with Class I and Class III malocclusions (Figure 9, 10, 11). Results of the longitudinal study on 8-14 years old Japanese females with Class III malocclusion demonstrated that 8-10 years old females had no changes in SGo/NMe values compared to Class I values, while 12 and 14 years old had significantly higher value than in Class I [27].

Results of our study defined that SGo/NMe proportion did not have a significant difference among genders in the same age subgruops, which is an accordance with results of Drevensek et al. [23]. In our study, difference according to the genders was noticed in the youngest (a) age subgroup of the children with Class III malocclusion only. Gender dimorphism in facial height was consider natural and is in accordance with all available studies up to date.

Drevensek et al. demonstrated interesting finding that gender dimorphism is frequently seen in children with normal intermaxillary relationship, especially in older subgroups, where male participants had greater linear heights of lower and total anterior face, while middle and older age subgroups had even greater posterior heights [23]. In children with Class III malocclusion, gender dimorphism was seen only in youngest age subgroup, where male participants had a significantly greater upper facial height in proportion to total anterior height (Table 2, 3).

Diversity of opinion on parameters values of cephalometric characteristics of skeletal Class III are supposed to be the expression of the ethnic composition of the groups studied. As previously stated, hyperdivergent growth type, determined by lower values of SGo/NMe proportion („long face“) is, according to many authors, considered a bad prognostic sign in therapy outcome [2]. In our study, we defined the mean values of proportional SGo/NMe relationships that were in normal range for children with class III malocclusion. However, the vertical proportions of the face are subject to change during growth. These changes depend on the model for the growth of the face. One of the most valid indicators of the growth model is the Björk polygon. In the Stojanovic's study in Serbian children with the III skeletal class, the average value of this parameter from 395 º ± 7.97 points to a favorable growth model for most respondents [28]. Such findings leave room for the successful application of early orthodontic therapy, which must be individually planned.

CONCLUSION

1. The face estimation in Class III malocclusion, especailly proportional relationship between anterior and posterior facial height, that defines growth convergention has a great practical importance in therapy plan of Class III malocclusion. Since values of proportional relationship SGo/NMe were in normal range for this children, we concluded that there is a great importance of early therapy for the Class III malocclusion.. This finding should definitely be used in modern concept of individually planned orthodontic therapy for optimal therapy outcome.

2. Gender dimorphism is more frequently observed in children with normal sagital intermaxilarry relationship, especially in the older age subgroups, where male participants had a greater linear lower anterior, total anterior and posterior facial height.

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Table 1. The measurements of this study and the result of subgroup comparison

The measurements parameters	Group	subgroup years	X ± SD		*p*
			M	**F**	
Upper anterior facial height NSna	1	**a/** 6–7.11	51.50 ± 4.28	49.17 ± 1.60	0.29 NS
		b/ 8–9.11	49.17 ± 3.57	52.17 ± 4.63	1.00 NS
		c/ 10–12	53.22 ± 3.42	53.29 ± 1.98	0.79 NS
	2	**a/** 6–7.11	49.67 ± 0.58	48.75 ± 1.50	0.27 NS
		b/ 8–9.11	52.46 ± 2.54	51.08 ± 2.63	0.37 NS
		c/ 10–12	53.64 ± 2.11	53.25 ± 3.28	0.59 NS
Lower anterior facial height SnaMe	1	**a/** 6 -7.11	65.00 ± 5.57	62.00 ± 3.41	0.94 NS
		b/ 8–9.11	65.50 ± 2.80	63.33 ± 4.85	0.32 NS
		c/ 10–12	67.56 ± 4.56	66.14 ± 3.76	0.56 NS
	2	**a/** 6–7.11	65.00 ± 5.57	66.25 ± 4.35	0.86 NS
		b/ 8–9.11	66.00 ± 3.07	62.39 ± 3.10	0.01**
		c/ 10–12	67.64 ± 3.44	63.13 ± 4.64	0.02*
Total anterior facial height NMe	1	**a/** 6–7.11	113.33 ± 8.12	111.60 ± 5.32	0.78 NS
		b/ 8–9.11	117.10 ± 4.84	115.50 ± 8.13	0.32 NS
		c/ 10–12	120.78 ± 6.26	119.43 ± 4.24	0.75 NS
	2	**a/** 6–7.11	114.67 ± 5.69	115.00 ± 4.97	1.00 NS
		b/ 8–9.11	118.46 ± 4.16	113.46 ± 4.70	0.02*
		c/ 10–12	121.27 ± 4.54	116.38 ± 4.31	0.05*
Posterior facial height SGo	1	**a/** 6–7.11	69.50 ± 5.54	67.00 ± 3.52	0.47 NS
		b/ 8–9.11	75.30 ± 4.64	73.00 ± 6.81	0.32 NS
		c/ 10–12	77.67 ± 8.22	75.86 ± 5.05	0.83 NS
	2	**a/** 6–7.11	74.33 ± 5.69	71.75 ± 4.92	0.48 NS
		b/ 8–9.11	76.36 ± 7.06	69.39 ± 6.25	0.02*
		c/ 10–12	74.82 ± 4.12	72.38 ± 5.98	0.51 NS

NS – p > 0.05 – not significant; * p < 0.05– significant; ** p ≤ 0.01 – highly significant, Mann–Whitney, Wilcoxon test.

Table 2. The proportions of measurements of this study and the result of subgroup comparison

The measurements parameters	Group	subgroup years	X ± SD		p
			M	**F**	
Proportional relationship NSna/NMe	1	**a**/ 6–7.1 1	45.4 1 ± 0.7 6	44.2 5 ± 0.7 2	0.0 1**
		b/ 8–9.1 1	44.0 4 ± 1.8 8	45.1 6 ± 2.1 5	0.2 0 NS
		c/ 10–12	44.0 8 ± 2.0 6	44.6 4 ± 1.6 8	0.4 9 NS
	2	**a**/ 6–7.1 1	43.3 8 ± 2.0 7	42.4 3 ± 1.6 1	0.4 8 NS
		b/ 8–9.1 1	44.2 9 ± 1.5 7	45.0 2 ± 1.4 5	0.2 4 NS
		c/ 10–12	44.2 4 ± 1.3 3	45.7 9 ± 2.8 5	0.1 9 NS
proportional relationship SnaMe/NMe	1	**a**/ 6–7.1 1	54.5 9 ± 0.7 6	55.7 5 ± 0.7 2	0.0 1**
		b/ 8–9.1 1	55.9 6 ± 1.8 8	54.8 4 ± 2.1 5	0.2 0 NS
		c/ 10–12	56.6 5 ± 3.3 8	55.3 6 ± 1.6 8	0.4 3 NS
	2	**a**/ 6–7.1 1	56.6 2 ± 2.0 7	57.5 7 ± 1.6 1	0.4 8 NS
		b/ 8–9.1 1	55.7 1 ± 1.5 7	54.9 8 ± 1.4 4	0.2 4 NS
		c/ 10–12	55.7 6 ± 1.3 3	54.2 1 ± 2.8 5	0.1 9 NS
Proportional relationship SGo/NMe	1	**a**/ 6–7.1 1	61.3 9 ± 3.8 6	60.2 8 ± 2.2 4	1.0 0 NS
		b/ 8–9.1 1	64.3 2 ± 3.2 4	63.3 6 ± 6.0 0	0.6 9 NS
		c/ 10–12	64.4 1 ± 4.7 1	63.5 6 ± 4.4 8	0.5 6 NS
	2	**a**/ 6–7.1 1	64.9 4 ± 6.1 0	62.3 6 ± 2.1 5	0.7 2 NS
		b/ 8–9.1 1	64.4 1 ± 4.6 0	61.1 3 ± 4.4 9	0.1 2 NS

Figure 1. Angular cephalometric measurements for selection into groups used in the study

SNA – angle of sagittal maxillary position in relation to the cranial base anterior,

SNB – angle of sagittal mandibulary position in relation to the cranial base anterior,

ANB – angle of sagittal intermaxillary relationship;

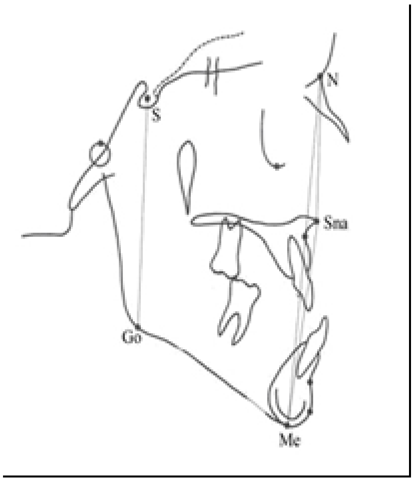

Figure 2. Cephalometric landmarks and linear measurements for assessmend facial height

S-sella (the center of sella turcica), N-nasion (the most anterior limit of suture nasofrontalis), Me-menton (the lowermost point on the shadow of the mandibular symphysis), Go-gonion (the most outward point on the angle formed by the junction of the ramus and body of the mandible on its posterior, inferior aspect), Sna-spina nasalis anterior (the apex of the anterior nasal spine),

NSna – upper anterior facial height

SnaMe – lower anterior facial height

Nme – total anterior facial height

Sgo – posterior facial height

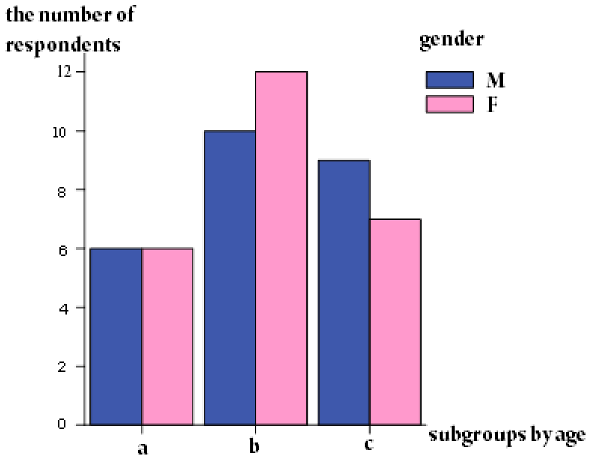

Figure 3. Distribution of respondents in subgroups according to gender and age in Group 1.

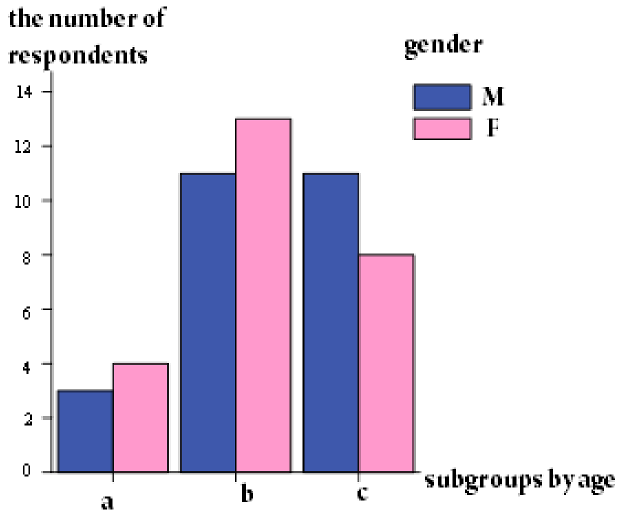

Figure 4. Distribution of respondents in subgroups according to gender and age in Group 2.

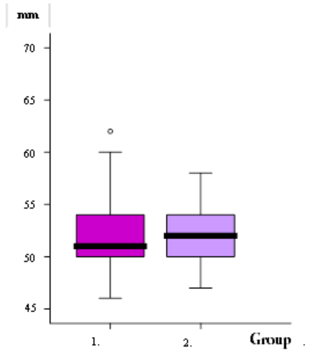

Figure 5 . The parameter values NSna

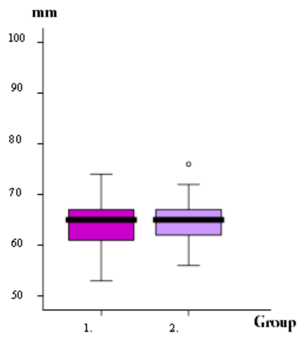

Figure 6. The parameter values SnaMe

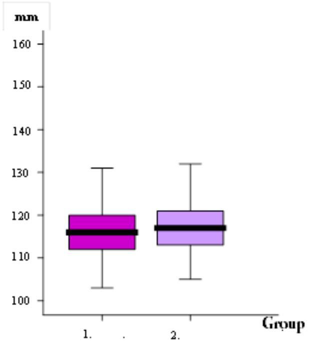

Figure 7. The parameter values NMe

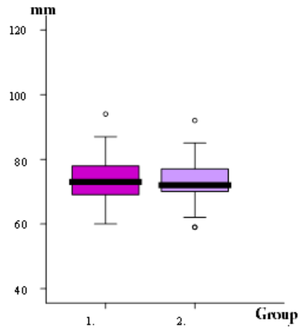

Figure 8. The parameter values SGo

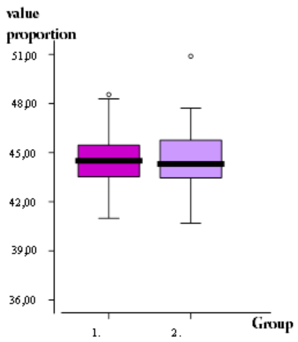

Figure 9. The parameter values NSna/NMe

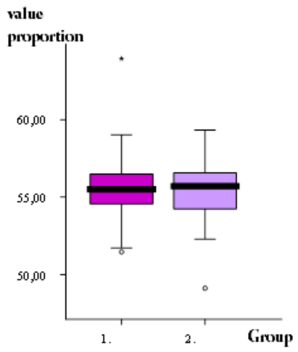

Figure 10. The parameter values SnaMe/NMe

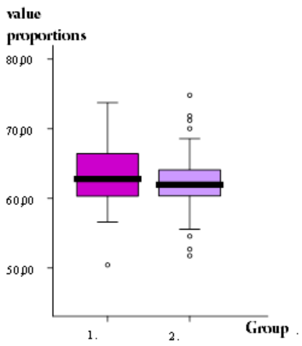

Figure 11. The parameter values SGo/NMe