

# NEEDLE PENETRATION DEPTH ACCORDING TO GENDER AND BODY MASS INDEX IN VENTROGLUTEAL INTRAMUSCULAR INJECTIONS IN ADULTS

## YETİŞKİNLERDE VENTROGLUTEAL İNTRAMÜSKÜLER ENJEKSİYONLARDA CİNSİYET VE BEDEN KİTLE İNDEKSİNE GÖRE İĞNE PENETRASYON DERİNLİĞİ

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### ABSTRACT

**Objective:** This study aimed to investigate the needle penetration depth in ventrogluteal intramuscular injections in adults, taking into account gender and body mass index (BMI).

**Material and Method:** This study was designed as correlational research with a sample of 232 patients. The ventrogluteal intramuscular injection area was identified using V and G methods and these points were examined under ultrasonography; the subcutaneous tissue, M. gluteus medius, and M. gluteus minimus thicknesses were defined by considering the gender and BMI. Data analysis was performed using arithmetic mean, standard deviation, frequency, percentage, Independent Samples t Test, and ANOVA.

**Result:** Needle penetration depth is between 20-48 mm in thin women, 18-53 mm in normal weight women, 29-62 mm in overweight women, and 26-88 mm in obese women; 23-37 mm in thin men, 18-41 mm in normal weight men, 25-50 mm in overweight men, and 17-82 mm in obese men. In addition, it was determined that needle penetration depth was statistically different according to the BMI category for both women and men ( $p<0.001$ ) and also statistically different according to gender ( $p<0.001$ ).

**Conclusion:** Particularly in overweight and obese women, longer needles should be used. In addition, considering BMI, the needle penetration depth in women should be greater than in men. It was found that the range of needle penetration depths

### ÖZET

**Amaç:** Bu çalışma, yetişkinlerde ventrogluteal bölgeye intramüsküler enjeksiyon sırasında cinsiyete ve beden kitle indeksi (BKİ) dikkate alınarak iğne penetrasyon derinliğini belirlemek amacıyla yapıldı.

**Gereç ve Yöntem:** İlişki arayıcı türde yapılan araştırmanın örneklemini 232 hastadan oluştu. V ve G yöntemleri ile ventrogluteal intramüsküler enjeksiyon alanı belirlendi ve bu noktalar ultrasonografi altında incelendi. Cinsiyet ve BKİ dikkate alınarak deri altı doku, M. gluteus medius ve M. gluteus minimus kalınlıkları saptandı. Veri analizi, aritmetik ortalama, standart sapma, frekans, yüzde, bağımsız örneklem t testi ve ANOVA kullanılarak yapıldı.

**Bulgular:** İğne penetrasyon derinliği zayıf kadınlarda 20-48 mm, normal kilolularda 18-53, kilolularda 29-62 mm, obezlerde 26-88 mm arasında; zayıf erkeklerde 23-37 mm, normal kilolularda 18-41 mm, fazla kilolularda 25-50 mm, obezlerde 17-82 mm arası uzunlukta bulundu. Ayrıca iğne penetrasyon derinliğinin BKİ sınıflamasına göre kadın ve erkeklerde istatistiksel olarak farklı olduğu belirlendi ( $p<0,001$ ) ve cinsiyete göre de istatistiksel olarak farklıydı ( $p<0,001$ )

**Sonuç:** Özellikle kilolu ve obez kadınlarda daha uzun iğneler tercih edilmelidir ve BKİ dikkate alınarak kadınlardaki iğne penetrasyon derinliği erkeklerden fazla olmalıdır. Ayrıca iğne penetrasyon derinliği aralığının geniş olduğu görülmektedir ve bu nedenle IM enjeksiyon uygulamasında, bireye özgü değerlendirmeler

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is wide and should therefore be assessed individually during IM injection; adipose tissue thickness and muscle condition should be assessed by palpating the area.

**Keywords:** Body mass index, gender, intramuscular injection, ventrogluteal area, needle penetration depth

me yapılmalı, yağ dokusunun kalınlığı ve kasların durumu bölge palpe edilerek tanılanmalıdır

**Anahtar Kelimeler:** Beden kitle indeksi, cinsiyet, kas içi enjeksiyon, ventrogluteal bölge, iğne penetrasyonu

## INTRODUCTION

Intramuscular (IM) injections involve many risks. Potential complications include abscesses, necrosis, tissue irritation, muscle tissue fibrosis, bone injury, and sciatic nerve damage. Of these, especially bone injury and injection of the medication into the subcutaneous tissue can be prevented by applying the needle to the correct location during injection, and specifically, by penetration into muscle (1-4).

For the drug to reach the gluteus medius muscle, all of the injector needles must reach the fascia part of the muscle. The interval to the gluteus medius muscle is defined by two elements: the thickness of subcutaneous adipose directly beneath the injection area, and the availability or tonus of the gluteus medius muscle (5-8). The needle length for IM injection is selected based on the patient's muscle development, body weight, and injection type (2).

Many needles that are available in healthcare environments are not long enough to reach muscle tissue, especially in women and obese individuals. Since most institutions only have needles ranging from 3/8 to 1.5 inches in length, nurses must seek alternate routes for medication, especially when IM injections are ordered for obese and women patients (9, 10).

The standard IM injection needle used in clinical practice (1.25 inches, 32 mm) reaches a penetration depth of about 30 mm (6-7). Subcutaneous adipose tissue thicker than 25 mm causes undesired drug accumulation, slower drug absorption, reduced drug efficacy, and local tissue damage (11). In IM injection, to effectively inject into the muscle tissue without damaging the bone by passing the subcutaneous tissue, the needle must have a sufficient length and an internal diameter that can vary depending on the type of drug. However, standard needles are sometimes unsuitable for injection into the gluteal muscle. Therefore, problems related to the issues of needle length and the type and amount of fluid to be injected IM should be adequately examined with evidence-based studies (7-9). Kaya et al.'s study provided a significant response to the questions regarding determining the area (3).

A needle of appropriate length should be chosen to allow the needle to penetrate the muscle during IM injection (1,3). The appropriate length can be determined ac-

cording to the gender and BMI of the individual (12-14). Gender, body weight, and height affect muscle and subcutaneous adipose distribution in the gluteal area (7,12). This study was conducted to define needle penetration depth (NPD) according to gender and body mass index for IM injections in the ventrogluteal area of adults. The research questions are as follows:

Does BMI affect NPD when IM injection is applied to the ventrogluteal area?

Does gender affect NPD when applying IM injection to the ventrogluteal area?

## MATERIAL and METHODS

### Study design

The study was conducted with a correlational design to define the NPD according to gender and BMI during IM injection in the ventrogluteal area in adults.

### Study population

The population of the study consisted of patients hospitalized in a university hospital between September 2017 and June 2018. The sample consisted of 232 randomly selected individuals.

### Data collection tools and procedures

**Patient information form:** Data were collected by a patient information form consisting of 14 questions created by reviewing the literature (1,3,6,12,13,15,16). This form, developed by the researchers, consists of two parts. In the first part, age, gender, height, weight, and BMI data were questioned. In the second part, ventrogluteal area data were examined under ultrasonography (presence and location of M. gluteus medius and M. gluteus minimus in the area defined by the G and V methods, the thickness of subcutaneous tissue in the designated area, M. gluteus medius and M. gluteus minimus thickness, etc.) were noted.

The individual who decided to be included in the study was informed in written and verbal ways, their volunteering was confirmed, height-weight was measured, and gender was recorded. The researcher determined the ventrogluteal area by the V method described in textbooks of nursing principles and marked the puncture area with a dermatograph as "V" (9,13). At the same time, the ventrogluteal area was determined again by the method specified in the literature and named the

geometric method and this puncture area was marked with a dermatograph as "G"(3,17). Another researcher authorized to perform ultrasonography determined the presence of M. gluteus medius and M. gluteus minimus, subcutaneous (SC) tissue, M. gluteus medius, and M. gluteus minimus thickness in the marked areas using ultrasonography. The distance between the skin and the bone was determined by collecting SC tissue, M. gluteus medius, and M. gluteus minimus thickness in the areas determined by the G and V methods. In IM injection, the needle tip is desired to come to the middle of the muscle layer. Therefore, to determine the NPD, M. gluteus medius and M. gluteus minimus thickness were summed and divided into two, and SC tissue thickness was added to this result.

It was carried out in compliance with the principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Istanbul University Istanbul Faculty of Medicine Clinical Research Ethics Committee (Date: 22.04.2015, No: 870). Participants were aware of the aim and advantages of the survey and their roles in the study. The written and verbal permit was obtained from the participants, denoting that they were aware of the pertinent aspects of the study.

#### Data analysis

Data were analyzed in the Statistical Package for Social Sciences Windows 22.0 program. Minimum, maximum values, arithmetic mean, and standard deviation were used for the evaluation of ordinal (continuous) data; frequency and percentage calculations were used to evaluate nominal (discontinuous) data. A Group Kolmogorov-Smirnov Goodness of Fit Test was applied to analyze the obtained data's normality. It was determined that the distributions were normal, and a t-test was used to determine the difference between the mean of two groups in independent groups, and one-way ANOVA methods were used to determine the difference between the means of more than two groups. Bonferroni method was applied for the Multiple Comparisons in cases where there was a significant difference. The level of significance for all analyses was set at  $p \leq 0.05$ .

#### RESULTS

The average age of the patients included in the study was  $35.02 \pm 10.62$  years (minimum=18, maximum=70), 58.2% were women and 41.8% were men. Among all cases, it was determined that 23.3% were underweight, 31.9% were normal weight, 25.4% were overweight, 19.4% were obese, and the average BMI was  $24.31 \pm 5.61$  (minimum=15, maximum=41). BMI classes according to gender are shown in Figure 1. Accordingly, 26.7% of women were underweight, 31.9% were normal weight according to height, 20.7% were overweight, and 20.7%

were obese, and the average BMI was 24.11 (SD=6.08, minimum=15, maximum=41). Also, the situation for men was 18.6% underweight, 32% normal weight, 32% (n=31) overweight, and 17% obese, and the mean BMI was 24.58 (SD=4.91, minimum=17.90, maximum = 40).

Needle penetration depth, SC tissue, M. Gluteus medius, M. Gluteus minimus, and total thickness values below the injection puncture point determined according to the G and V methods in women and men were examined according to BMI (Tables 1,2,3 and 4).

In the G method, needle penetration depth was found to be between 20.4-48.3 mm for under-weight women, 18.6-53.8 mm for normal-weight women, 29.7-62.5 mm for overweight women, and 26.7-88.0 mm for obese women. In addition, it was determined that NPD was statistically different according to BMI classes ( $p < 0.001$ ) and this difference was because the mean value of depth of the needle in under-weight and normal-weight women was statistically significantly lower than in overweight and obese women (Table 1). Similar results were obtained in the V method (Table 2).

When the area was determined according to the G method, needle penetration depth was found to be between 23.0-37.5 mm for under-weight men, 18.9-41.5 mm for normal-weight, 25.7-50.4 mm for overweight, and 17.5-82.3 mm for obese. In addition, it was determined that the needle length was statistically different according to BMI classes ( $p < 0.001$ ). Multiple comparisons showed that the mean depth of needle value was statistically lower in under-weight men than obese, and in normal-weight men than in overweight and obese men (Table 3). Similar results were obtained in the measurements obtained by determining the area with the V method (Table 4).

Table 5: Shows that the NPD was statistically different according to gender in both methods ( $p < 0.001$ ).

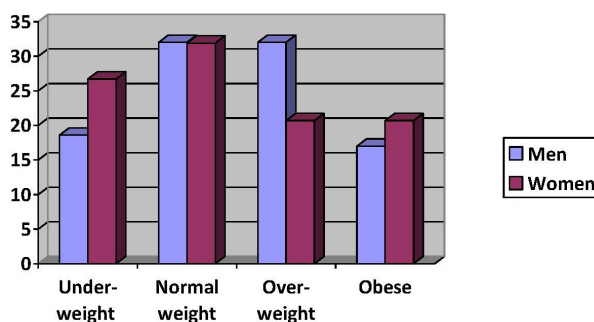


Figure 1: Distribution of body mass index categories by gender

**Table 1:** Distribution of thickness values for SC tissue. *M. gluteus medius*. and *M. gluteus minimus*, and needle penetration depth according to BMI categories of women in areas determined by G methods (n=135)

Body mass index categories	n (%)	SC tissue thickness	MG medius thickness	MG minimus thickness	Total thickness
		Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)
		MG medius+MG minimus thickness/2			
		Mean±SD (Min.-Max.)			
<b>Under-weight (a)</b>	36 (26.7)	12.8±3.9 4.5-17.5	17.9±5.6 8.1-28.1	20.2±7.2 9.2-33.5	50.8±11.8 32.1-79.1
<b>Needle penetration depth* (w)</b>			19.0±4.7 11.8-30.8		31.8±7.4 20.4-48.3
<b>Normal weight (b)</b>	43 (31.9)	16.2±5.6 6.1-26.5	22.0±5.1 10.0-30.0	16.7±5.5 7.3-30.6	54.8±11.6 31.1-83.6
<b>Needle penetration depth* (x)</b>			19.3±4.2 11.0-29.8		35.5±8.1 18.6-53.8
<b>Overweight (c)</b>	28 (20.7)	23.6±8.0 10.5-47.0	24.4±5.8 9.5-34.0	18.0±7.0 6.5-35.0	66.0±11.1 46.7-86.8
<b>Needle penetration depth* (y)</b>			21.2±5.3 10.8-31.5		44.8±8.1 29.7-62.5
<b>Obese (d)</b>	28 (20.7)	26.0±12.5 10.2-59.0	23.4±8.4 9.0-39.9	19.9±6.1 9.4-32.0	69.3±16.7 41.2-117.0
<b>Needle penetration depth* (z)</b>			21.6±5.7 14.5-33.6		47.6±13.6 26.7-88.0
<b>ANOVA for tissue thicknesses</b>		F=20.897 p=0.000 a<c,d; b<c,d	F=7.002 p=0.000 a<b,c,d	<b>F=2.451</b> <b>p=0.066</b>	F=15.228 p=0.000 a<c,d; b<c,d
<b>ANOVA for needle penetration depth</b>			<b>F=2.239</b> <b>p=0.087</b>		F=20.794 p=0.000 w<y,z; x<y,z

BMI: Body Mass Index, SD: Standard deviation, Min: Minimum, Max: Maximum, a: Under-weight, w: Needle penetration depth for under-weight, b: Normal weight, x: Needle penetration depth for normal weight, c: Overweight, y: Needle penetration depth for overweight, d: Obese, z: Needle penetration depth for obese, \*: Needle penetration depth is half of the total thickness of *m.gluteus medius* and *m.gluteus minimus* plus the sum of SC tissue thickness, \*\*: Half the total thickness of *m.gluteus medius* and *m.gluteus minimus*

## DISCUSSION

In the study, the IM injection puncture point in the ventrogluteal area was determined using the V and G methods, and the thickness of the SC tissue, gluteus medius, and gluteus minimus muscles in these areas were measured using ultrasound. Furthermore, the distance from skin to bone was calculated as part of the investigation. Understanding these distances is crucial, particularly to avoid needle retention in the SC tissue and to prevent bone injuries during IM injections (8).

In the literature, it is stated that the ventrogluteal area is an area that can be used safely in place of the dor-

sogluteal area (13). The muscle tissue in the ventrogluteal area is thicker than the dorsogluteal area, the subcutaneous adipose tissue is thinner. The thinner subcutaneous adipose tissue in this area reduces the possibility of the injection being made into the SC tissue by mistake. On the other hand, there are no large nerves and blood vessels in this area, but it is innervated with small nerves and blood builds up through the arms of the blood vessels, which prevents the occurrence of more serious injuries (16). In addition, the ventrogluteal area is preferred because of the easy position to be given to the patient, and it is easy to determine the ventrogluteal area since bone protrusions can be easily felt by hand (2, 9, 13). Consequently, the ventrogluteal area should be used instead of the commonly-used dorsogluteal area. However, nurs-

**Table 2:** Distribution of thickness values for SC tissue. *M. gluteus medius*. and *M. gluteus minimus*. and needle penetration depth according to BMI categories of women in areas determined by V methods (n=135)

Body mass index categories	n (%)	SC tissue thickness	MG medius thickness	MG minimus thickness	Total thickness
		Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)
		MG medius+MG minimus thickness/2			
		Mean±SD (Min.-Max.)			
<b>Under-weight (a)</b>	36 (26.7)	11.9±5.8 4.9-24.0	17.2±7.3 1.7-29.4	20.0±7.4 7.1-32.7	49.1±15.6 18.0-80.9
<b>Needle penetration depth* (w)</b>			18.6±6.5** 4.4-30.2		30.5±9.9 13.6-50.7
<b>Normal weight (b)</b>	43 (31.9)	21.5±7.2 6.9-40.5	23.7±4.9 10.2-31.0	14.8±6.1 4.5-35.0	59.9±9.8 32.1-85.9
<b>Needle penetration depth* (x)</b>			19.2±3.8** 11.2-30.1		40.7±7.7 20.9-58.3
<b>Overweight (c)</b>	28 (20.7)	23.7±9.8 10.5-51.0	26.2±6.9 9.5-47.6	18.5±6.9 1.7-32.0	68.4±12.0 41.7-99.1
<b>Needle penetration depth* (y)</b>			22.4±5.2** 14.1-33.8		46.1±9.7 27.6-75.1
<b>Obese (d)</b>	28 (20.7)	29.8±13.4 10.5-58.5	25.4±10.1 10.2-48.1	19.9±7.9 7.8-38.6	75.1±13.4 41.4-96.1
<b>Needle penetration depth* (z)</b>			22.7±7.9** 10.4-40.8		52.4±10.8 31.0-77.3
<b>ANOVA for tissue thicknesses</b>		F=21.557 p=0.000 a<b,c,d; b<d	F=10.779 p=0.000 a<b,c,d	F=4.712 p=0.004 b<a,d	F=24.905 p=0.000 a<b,c,d; b<c,d
<b>ANOVA for needle penetration depth</b>			F=4.214 p=0.007 w<z		F=31.335 p=0.000 w<x,y,z; x<z

BMI: Body Mass Index, SD: Standard deviation, Min: Minimum, Max: Maximum, a: Under-weight, w: Needle penetration depth for under-weight, b: Normal weight, x: Needle penetration depth for normal weight, c: Overweight, y: Needle penetration depth for overweight, d: Obese, z: Needle penetration depth for obese, \*: Needle penetration depth is half of the total thickness of *m.gluteus medius* and *m.gluteus minimus* plus the sum of SC tissue thickness, \*\*: Half the total thickness of *m.gluteus medius* and *m.gluteus minimus*

es prefer the dorsogluteal area more in clinical practice. One of the reasons for this is that nurses have doubts about whether there is muscle tissue in the ventrogluteal area (12, 16).

Various tools and equipment are used in drug administration by IM injection. There are different injectors and needles. Each of these is designed to deliver a certain volume of drugs to tissues with certain properties. Nurses must decide on the tools and equipment to use considering the IM injection application area, the drug to be given, etc. Standard injectors have a capacity of 2,5,10 ml. Standard injectors are available without needles or with needles with a diameter of 18,21,22,23,25 numbers, and 10.16-76.2 mm in length. Injector needles are individ-

ually packaged and available in various sizes and diameters (2,6,7,9). In Türkiye, the inner diameter numbers of the needles are 20,21,22,23,26, and needle lengths are ½ inch (12.5 mm), 1 inch corresponds to 25 mm, 1 ¼ inch to 31.25 mm, and 1 ½ inch to 37.5 mm in length.

IM injection is usually applied to adults using 2 ml or 5 ml syringes with a 25.4-50.8 mm length and medium width (21-22 or 23 numbers in diameter) needle (9). Several research groups studied the risk of short needles inadvertently interpenetrating the intramuscular level and delivering the drug in the subcutaneous adipose tissue. Overpenetration can cause pain and/or damage to the bone or periosteum in the patient. It can also cause the needle to detach from the syringe (8,9,19). This study

**Table 3:** Distribution of thickness values for SC tissue. *M. gluteus medius*. and *M. gluteus minimus*. and needle penetration depth according to BMI categories of men in areas determined by G methods (n=97)

Body mass index categories	n (%)	SC tissue thickness	MG medius thickness	MG minimus thickness	Total thickness
		Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)
		MG medius+MG minimus thickness/2			
		Mean±SD (Min.-Max.)			
<b>Under-weight (a)</b>	18 (18.6)	8.2±4.0 4.5-16.5	22.8±8.1 10.0-34.0	24.3±4.4 16.0-29.0	55.3±9.9 41.5-69.0
<b>Needle penetration depth* (w)</b>				23.6±4.9** 18.5-31.5	31.8±5.8 23.0-37.5
<b>Normal weight (b)</b>	31 (32.0)	9.7±4.5 3.3-20.5	20.6±7.2 7.0-36.7	18.3±6.9 9.0-40.0	48.6±9.1 33.0-74.0
<b>Needle penetration depth* (x)</b>				19.4±4.6** 9.3-32.5	29.1±5.5 18.9-41.5
<b>Overweight (c)</b>	31 (32.0)	13.8±4.9 7.5-29.8	22.8±5.8 9.0-33.1	21.2±6.7 9.4-40.0	57.8±10.1 37.5-83.7
<b>Needle penetration depth* (y)</b>				22.0±5.0** 10.8-33.4	35.8±6.2 25.7-50.4
<b>Obese (d)</b>	17 (17.5)	19.5±12.5 10.0-62.2	21.3±7.5 2.9-30.9	21.1±7.6 2.0-32.0	61.8±17.4 25.0-102.3
<b>Needle penetration depth* (z)</b>				21.2±6.5** 7.5-29.3	40.6±13.7 17.5-82.3
<b>ANOVA for tissue thicknesses</b>		F=11.026 p=0.000 a<c,d; b,c<d;	<b>F=0.668</b> <b>p=0.574</b>	F=3.276 p=0.025 a>b	F=5.962 p=0.001 b<c,d
<b>ANOVA for needle penetration depth</b>				F=2.700 p=0.05 w>x	F=9.256 p=0.000 w<z; x<y,z

BMI: Body Mass Index, SD: Standard deviation, Min.: Minimum, Max.: Maximum, a: Under-weight, w: Needle penetration depth for under-weight, b: Normal weight, x: Needle penetration depth for normal weight, c: Overweight, y: Needle penetration depth for overweight, d: Obese, z: Needle penetration depth for obese, \*: Needle penetration depth is half of the total thickness of *m.gluteus medius* and *m.gluteus minimus* plus the sum of SC tissue thickness. \*\*: Half the total thickness of *m.gluteus medius* and *m.gluteus minimus*

showed that while administering the IM injection to the ventrogluteal area, standard needles could not even pass SC tissue in overweight, obese women and men when the area was determined according to the G and V methods. Consequently, long needles should be used for IM injection, so the needle passes through the subcutaneous tissue, and reaches deep muscle tissue.

Body mass index and the amount of adipose tissue affect the choice of needle size. For instance, a 76 mm long needle is often required for an obese individual, whereas a 13 mm-25 mm long needle is sufficient for an underweight individual (3,9,13). Both BMI and gender were found to be factors affecting SC tissue thickness in this study. Ozen et al. in their study determined that

subcutaneous adipose tissue (SAT) thickness values are important if IM drug injection is to be administered correctly. Unsuccessful IM injections may be seen even in patients with appropriate SAT thicknesses (18). In addition, in the study by Nisbet, 12 out of 100 individuals included in the study were found to have SC tissue thickness of more than 35 mm in the ventrogluteal area, and it was determined that muscle tissue could not be reached in these individuals when standard needles were used (20). As a result, when IM injection is applied to the ventrogluteal area, there is a risk that the needle cannot reach the target muscle mass, and the most important factor causing this risk is BMI. Thus, when intramuscular injections are to be administered to *M. gluteus*

**Table 4:** Distribution of thickness values for SC tissue. *M. gluteus medius*. and *M. gluteus minimus*. and needle penetration depth according to BMI categories of men in areas determined by V methods (n=97)

Body mass index categories	n (%)	SC Tissue Thickness	MG Medius Thickness	MG Minimus Thickness	Total Thickness
		Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)
		MG medius+MG minimus thickness/2			Mean±SD (Min.-Max.)
Under-weight (a)	18 (18.6)	9.6±3.7 7.0-17.0	26.3±5.2 18.0-32.5	22.3±3.3 17.5-27.5	58.3±8.6 47.5-68.0
Needle penetration depth* (w)			24.3±3.7** 20.3-29.8		33.9±5.5 27.3-40.8
Normal weight (b)	31 (32.0)	10.7±4.9 4.4-26.3	20.9±7.5 5.0-32.9	16.8±8.6 1.1-37.5	48.5±10.1 24.0-70.5
Needle penetration depth* (x)			18.9±5.0** 7.0-32.3		29.6±6.2 16.0-45.3
Overweight (c)	31 (32.0)	16.8±4.7 10.0-30.0	24.0±8.5 7.0-38.8	19.1±7.5 6.7-36.3	59.9±12.3 32.0-87.9
Needle penetration depth* (y)			21.6±6.0** 9.8-33.6		38.4±7.1 22.0-54.4
Obese (d)	17 (17.5)	20.7±11.1 10.0-48.0	21.8±6.7 9.5-32.7	20.4±7.4 11.0-34.7	62.9±11.6 40.0-80.7
Needle penetration depth* (z)			21.1±5.7** 11.0-30.4		41.8±9.8 28.5-63.0
ANOVA for tissue thicknesses		F=14.574 p=0.000 a<c,d; b<c,d;	<b>F=2.393</b> <b>p=0.073</b>	<b>F=2.358</b> <b>p=0.077</b>	F=8.735 p=0.000 b<a,c,d
ANOVA for needle penetration depth			F=4.172 p=0.008 w>x		F=13.448 p=0.000 w<z; x<y,z

BMI: Body Mass Index, SD: Standard deviation, Min.: Minimum, Max.: Maximum, a: Under-weight, w: Needle penetration depth for under-weight, b: Normal weight, x: Needle penetration depth for normal weight, c: Overweight, y: Needle penetration depth for overweight, d: Obese, z: Needle penetration depth for obese\*: Needle penetration depth is half of the total thickness of *m.gluteus medius* and *m.gluteus minimus* plus the sum of SC tissue thickness. \*\*: Half the total thickness of *m.gluteus medius* and *m.gluteus minimus*

**Table 5:** Distribution of thickness values for SC tissue. *M. gluteus medius*. and *M. gluteus minimus*. and needle penetration depth according to gender in areas determined by G and V methods

	METHOD G			METHOD V		
	Women (n=135)	Men (n=97)	t*; p	Women (n=135)	Men (n=97)	t*; p
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
SC tissue thickness	18.8±9.3	12.4±7.6	5.598; 0.000	21.1±11.0	14.2±7.4	5.722; 0.000
MG medius thickness	21.7±6.6	21.8±7.0	<b>-0.159; 0.874</b>	22.8±8.0	23.1±7.5	<b>-0.251; 0.802</b>
MG minimus thickness	18.5±6.5	20.8±6.8	-2.586; 0.01	18.0±7.3	19.2±7.5	<b>-1.227; 0.221</b>
Total thickness	59.1±14.7	55.1±12.2	2.183; 0.030	61.9±15.8	56.5±12.1	2.841; 0.005
Needle penetration depth	39.0±11.2	33.8±8.7	3.975; 0.000	41.5±12.2	35.3±8.4	4.568; 0.000

BMI: Body Mass Index, SD: Standard deviation, Min.: Minimum, Max.: Maximum, \*: Independent Samples t Test

medius and minimus, the length of the needle should be chosen according to the patient's BMI (2,7,9).

In this study, while administering the IM injection to the ventrogluteal area, when the area was determined according to the G, V methods, the SC tissue thickness of the woman was higher than man. Subcutaneous tissue is found below the layer of the dermis. Dermis and SC tissue thickness can be estimated by BMI. The subcutaneous tissue thickness of women is more than that of men across all BMI ranges (21). This finding was found to be like other studies conducted (3,21). Finally, the sample size is limited to this hospital; therefore, the generalizability of study findings to other settings may be limited.

This study showed that when administering IM injection to the ventrogluteal area, standard needles should not be used, and needle length should be decided according to gender and BMI. But the longest of the needles used for this purpose on the market is 2.5-3.75 cm. In addition, clear guidelines should be prepared about the gold standard technique for nurses (22). There are no prescribed guidelines for choosing the correct needle length based on an individual's BMI and gender. Without updated guidelines, IM injections will continue to be administered inappropriately into muscles (23).

#### Limitations of the study

In the IM injection, the age and level of exercise of the individual affect the depth of needle penetration. In this study, NPD could not be analyzed according to age classes (the number of individuals over 65 is insufficient and the maximum age is 70), since the individuals within the scope of the study were generally adults (35.02±10.62 years, minimum=18, maximum=70). The effect of exercise status on NPD could not be analyzed since measurement tools were not applied to determine the exercise status of the individuals within the scope of the study and the general condition of the muscles.

#### CONCLUSION

This study showed that NPD should be different according to BMI and gender. A needle length of 20-48 mm should be used in thin women, 18-53 mm in normal weights, 29-62 mm in overweight, and 26-88 mm in obese women. A needle length of 23-37 mm should be used in thin men, 18-41 mm in normal weights, 25-50 mm in overweight, and 17-82 mm in obese men.

Longer needles should be preferred especially in overweight and obese women, and NPD in women should be greater than in men, taking into account BMI. In addition, it is seen that the range of NPD is wide and therefore, individual evaluation should be made while injecting IM, the thickness of the adipose tissue and the condition of the muscles should be diagnosed by palpating the area.

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