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IDENTIFICATION OF THE FACTORS AFFECTING PELVIC FLOOR MUSCLE STRENGTH IN WOMEN

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ABSTRACT

Providing dynamic support to the pelvic organs by adjusting their tension against changing conditions, the pelvic floor muscles lose their strength over time and their supporting functions decline as a result of the effects of certain mechanical, hormonal and neural factors.

This study aims to determine the factors affecting pelvic floor muscle strength by measuring the pelvic floor muscle strength of the non-pregnant women who consulted the Karabuk University Training and Research Hospital Gynecology Outpatient Clinic for any reason.

This study involved a screening method. Stratified sampling was used as the sampling method. 516 women aged 20-77 participated in the study. The data were collected between 01 June 2017-2018 and the chi-squared test was used in the analysis.

In the study, pelvic floor muscle strength was found to be 11.6±5.9 cmH_2O on average. Statistically significant results were found between the pelvic floor muscle strength in women and their data of body mass index, age, educational status, place of residence, employment status, age of first pregnancy, delivery method, menopausal condition and contraceptive method.

As a result, it can be said that healthcare professionals should be informed about the risk factors adversely affecting pelvic floor muscle strength and their participation in exercise programs on this matter should be encouraged. Women should also be provided with information and training on pelvic floor muscle strength.

Keywords: pelvic floor, perineometer, menopause, age, working status, delivery method.

1. INTRODUCTION

The pelvic floor is an anatomic structure that is composed of muscle fibers, connective tissue underneath the pelvis and fascia. The main function of the pelvic floor is to support the pelvic organs and prevent incontinence by providing voluntary urethral and anal sphincter closure. The whole structure that makes up the pelvic floor dynamically regulates the functions of the pelvic organs and their canals (rectum, urethra and vagina) that open to the external environment. These functions include support for the pelvic organs, as well as micturition, defecation, sexual intercourse and birth (Graziottin, 2004). To maintain these vital functions, the strength of the bone, muscle fibers and connective tissue of the pelvic floor and the healthy nerve innervation of the region are extremely important (Arslan, 2007; Özdemir, 2015; Polat, 2012; Cangöl, 2013). Because of this multifunctional structure of the pelvic floor, any damage that may occur can have negative effects on a woman's life, primarily sexual problems as well as urinary and fecal incontinence, prolapse and chronic pelvic pain with advancing age. These problems, which are mainly caused by the relative damage to the pelvic floor muscles, are referred to as pelvic floor dysfunction (PFD) (Arslan, 2007; Demirtürk, 2006). PFD is a common health problem that does not threaten life; however, it adversely affects women's physical, social, work and educational activities and greatly reduces the quality of life. Although many factors predispose to the development of PFD, the most important factor is age and genetic predisposition. Other identified risk factors include the increase in intra-abdominal pressure such as obesity and constipation (Karahan, 2010; Yılmaz E, 2014), increased number of deliveries, advanced maternal age at the first delivery (over 30 years of age), giving birth to an over 4000g baby, prolonged labor, especially prolonged second stage of labor, operative deliveries, epidural analgesia, wide episiotomy and use of prostaglandin for induction of labor (Tanrıverdi, 2004; Philips, 2005; Özdemir 2015).

In the evaluation of PFD that develops due to pelvic floor muscle damage, the strength and endurance of the muscles are measured. Digital palpation, perineometer and electromyography are frequently used for this task (Akbayrak, 1997). Women who experience PFD may see themselves as deficient and flawed. Their physical and social lives may be restricted due to smell and cleaning problems and they may avoid sex and the company of other people, which can cause emotional problems such as anxiety and depression depending on the deteriorated body image. Despite feeling a sense of embarrassment, women who go through these problems generally do not consult any health institution due to the perception that these problems are a natural result of advancing age (Yılmaz, 2014).

Hence, this study focuses on the measurement of the pelvic floor muscle pressure in women by using a perineometer device to determine its relationship with variables that may affect the pelvic floor muscle strength such as body mass index (BMI), age, educational status, place of residence, employment status, age of first birth, method of delivery, menopausal status and contraception method.

2. MATERIALS AND METHODS

This research was planned to determine the factors that affect the strength of the pelvic floor muscles. For this purpose, the sample selection method was not used because the sampling frame of the study was not known exactly.

All non-pregnant women who consulted the Karabuk University Education and Research Hospital Gynecology and Obstetrics Clinic between 01 June 2017-18 for any reason, accepted to participate in the study, could speak and understand Turkish and did not have any surgical operation due to PFD. This involved 516 women.

After the Ethics Committee Approval dated 12.05.2016 and numbered 2016/05 was obtained with the decision of Karabuk University Ethics Advisory Board, necessary permissions were obtained from the management of Karabuk University Training and Research Hospital to collect data for the research.

In the study, the women who consulted the gynecology outpatient clinic and who met the sampling criteria were given detailed information about the study and their consent was obtained. The "Data Collection Form" was applied with a survey method, then the women were guided for the gynecological examination table. A digital perineometer device was used to evaluate the women's pelvic floor muscle strengths. (Figure 1). To provide aseptic conditions, a condom was each time put on the perineometer's probe that was inserted into the vagina (Akbayrak, 1997). Then the women were asked to tighten the probe by contracting their vagina muscles and the value measured from the manometer on the perineometer was recorded on the data collection form. Women were divided into two groups as ≤12 and >12-≤30 according to the perineometer measurement values.

The data obtained from the research were analyzed using the SPSS 18.0 statistical software package on Windows XP operating system. Following the descriptive statistical analysis (frequency, percentage distribution, mean±standard deviation), $p<0.05$ value was considered statistically significant.

3. RESULTS

The average age of the 516 women that participated in the study was 44.5±10.6, the average height was 160.9±6.2, the average weight was 73.9±13.3 and the BMI was 28.60±5.12 (Table 1).

Table 1. Demographic Characteristics of Women

Personal characteristics	**N**	**Min.**	**Max.**	**Average**	**S**
Age (year)	516	20	77	44.5	10.6
Height (cm)	516	142.0	178.0	160.9	6.2
Weight (kg)	516	42.0	123.0	73.9	13.3
BMI	516	18.20	53.30	28.60	5.12

The lowest pelvic floor muscle strength value in the group was 2cmH_2O and the highest 30cmH_2O 68% of those included in the study had a pelvic floor muscle strength value below 12cmH_2O and 32% of them had a value between 12-30cmH_2O (Table 2).

Table 2. Distribution of Women Included in the Study According to Pelvic Floor Muscle Strength Values

Pelvic Floor Muscle Strength Value	**Number of Women**	**%**
≤12 (lowest)	320	68.0
>12 ve ≤30 (low)	196	32.0
>30 ve ≤60 (normal)	0	0
Total	430	100.0

When the relationship between perineometer values and BMI of the women was examined, the ratio in those with a BMI between 25.0-<30 was found to be high (38.8%), followed by those with BMI ≥30 (35.5%) in the second place, and those between 18.5-<25.0 in the third place (25.8%)

The majority of women with a perineometer value of ≤12 (39.4%) were found to have a BMI of ≥30. The majority of women with perineometer value >12-≤30 (39.8%) were found to have a BMI between 25.0-<30. A statistically significant correlation was found between BMI and perineometer value (p<0.05) (Table 3).

Table 3. Comparison of BMI and Perineometer Values

BMI (kg/m²)	**Perineometer Value**					
	≤12		**>12 -≤30**		**Total**	
	S	**%**	**S**	**%**	**S**	**%**
18.5-<25.0 (Normal)	72	22.5	61	31.1	133	25.8
25.0-<30 (Overweight)	122	38.1	78	39.8	200	38.8
≥30 (Obese)	126	39.4	57	29.1	183	35.5
Total	320	100.0	196	100.0	516	100.0
	X^2=7.225; sd=2; *p=0.027					

*** p<0.05**

When the place of residence is evaluated; It was found that women with a perineometer value ≤12 mostly lived in city centers (56.6%), followed by districts (32.5%) and villages (10.9%). Women with >12 and ≤30 perineometer values were found to live in city centers (66.8%), followed by districts (24.0%) and villages (9.2%). The values found were statistically significant (p<0.05). The evaluation of the educational status of the women indicated that those with a perineometer value ≤12 were mostly primary school graduates (67.2%), followed by high school graduates (14.7%), literates (13.4%) and university graduates (4.7%). The women with perineometer values >12 and ≤30 were found to be primary school graduates (54.1%), followed by high school graduates (22.4%), university graduates (15.8%) and literates (7.7%). A statistically significant (p<0.05) result was found between the educational status of women and perineometer values (Table 4).

Table 4. Comparison of the Place of Residence and Educational Status with Perineometer Values

Place of Residence	**Perineometer Values**					
	≤12		**>12 and ≤30**		**Total**	
	S	**%**	**S**	**%**	**S**	**%**
Town center	181	56.6	131	66.8	312	60.5
County	104	32.5	47	24.0	151	29.3
Village	35	10.9	18	9.2	53	10.3
Total	320	100.0	196	100.0	516	100.0
	X^2=5.501		**sd=2**		**p=.050***	

Educational Status						
Literate	43	13.4	15	7.7	58	11.2
Primary education	215	67.2	106	54.1	321	62.2
High school	47	14.7	44	22.4	91	17.6
University	15	4.7	31	15.8	46	8.9
Total	320	100.0	196	100.0	516	100.0
	X^2=28.013		**sd=3**	**p=.000***		

*** p<0.05,** **p>0.05

The evaluation of the perineometer values and the ages of the women indicated that the ratio in those aged 46 and over was high (41.9%), followed by those who were 36-45 years old (40.5%), and 35 years old and below (17.6%). In the group with a perineometer value ≤12, those aged 46 and over were found to be 71.3%, followed by those who were 36-45 years old (55.5%), and 35 years old and under (54.9%). Those with a perineometer value >12 were found to be higher in the 35 years old and under group (45.1%). A significant inverse correlation was found between the ages of the women and the perineometer values ($p<0.05$). When the delivery methods of the women in the study were examined, it was observed that the ratios in those that had a natural delivery were high (64.4%), followed by those who had a cesarean delivery (24.4%), and those who had a natural and cesarean delivery (11.2%). It was found that those with a perineometer value ≤12 mostly had a natural delivery (67.5%), and those with a perineometer value >12 mostly delivered by cesarean delivery (46.6%). The perineometer value was significantly lower in those who gave birth naturally ($p<0.05$). When the perineometer values of women were compared with the age of first birth, the group with a perineometer value ≤12 consisted of those who gave birth at the age of 21 and younger with 55%, and those who gave birth at the age of 22 and older with 45%. Those with a perineometer value >12 were found to be 48.6% and 51.4%, respectively. Consequently, perineometer values were lower in women who were under 21 years of age; however, it was not statistically significant. It was observed that 72.9% of the women included in the study were in the reproductive period and 12.1% of them were in the menopausal period. The statistical examination of the relationship between the perineometer values and menopausal status of the women showed that there was a significant correlation ($p<0.05$). When the contraception methods of the women and perineometer values were examined, it was observed that those who did not use any method in both groups were in the majority ("≤12"=%53.1, ">12 and ≤30"=%37.8). According to the results of the chi-squared test, the correlation between the methods of contraception and perineometer values was statistically significant ($p<0.05$). When both perineometer values and working status of the women were examined, it was found that those who did not work had a higher ratio with 84.4% and 75%, respectively. A statistically significant ($p<0.05$) result was found between the working status of women and the perineometer values (Table 5).

Table 5. Comparison of Women's Age, Method of Birth, Age of First Birth, Menopause Condition, Contraception Methods and Working Status and Perineometer Values

		Perineometer Values					
		≤12		>12 and ≤30		Total	
		S	%	S	%	S	%
Age (n=516)	35 years and under	50	54.9	41	45.1	91	17.6
	36-45 years	116	55.5	93	44.5	209	40.5
	46 years and over	154	71.3	62	28.7	216	41.9
	Total	320	62.0	196	38.0	516	100.0
		X^2=13.593		**sd=2**	**p=.001***		
Method of Birth (n=483)	Normal	210	67.5	101	32.5	311	64.4
	Caesarean and	63	53.4	55	46.6	118	24.4
	Normal Caesarean	29	53.7	25	46.3	54	11.2
	Total	302	62,5	181	37.5	483	100.0
		X^2=9.313		**sd=2**	**p=.009***		
Age of first birth (n=483)	≤21	166	55.0	88	48.6	254	52.6
	≥22	136	45.0	93	51.4	229	47.4
	Total	302	100.0	181	100.0	483	100.0
		X^2=1.829		**sd=1**	**p=.104****		
Menopause condition (n=516)	No	217	57.7	159	42.3	376	72.9
	Yes	103	73.6	37	26.4	140	27.1
	Total	320	62.0	196	38.0	516	100.0
		X^2=10.892		**sd=1**	**p=.0.01***		
I don't use		170	53.1	74	37.8	244	47.3

Retraction	60	18.8	43	21.9	103	20.0
Pill	9	2.8	5	2.6	14	2.7
Intrauterine device	40	12.5	45	23.0	85	16.5
Condom	39	12.2	29	14.8	68	13.2
In-arm implant	2	0.6	0.0	0.0	2	0.4
Total	320	100.0	196	100.0	516	100.0
	X^2=16.647		**sd=5**	**p=.005***		
Not working	270	84.4	144	73.5	414	80.2
Working	50	15.6	52	26.5	102	19.8
Total	320	100.0	196	100.0	516	100.0
	X^2=9.115		**sd=1**	**p=.002***		

*** p<0.05,** **p>0.05

4. DISCUSSION

The pelvic floor has many important functions for miction, defecation, sexual life and giving birth. Dysfunctions caused by the softening of the pelvic floor can lead to pelvic organ prolapse (POP), stress urinary incontinence (SUI), other lower urinary tract, excretory and sexual dysfunctions, as well as some chronic pelvic pain syndromes (Polat, 2012). Pelvic floor dysfunction is often used to describe continence disorders and POPs, which adversely affects an individual's quality of life as this disorder causes impairment in physical, social and sexual functions (Özdemir, 2015).

On the evaluation of the pelvic floor muscle strength; observation, palpation, ultrasound, electromyography, vaginal cones, magnetic resonance imaging technique, as well as a perineometer device are widely used (Bo&Sherburn, 2005). Studies have shown that perineometer is a valid and reliable measurement tool for this evaluation (Morkved, 2004). Yet, there are few studies in which the classification of pelvic floor muscle strength has been performed by using perineometer values. In a study conducted in the city center of Malatya province, the pelvic floor muscle strengths of 430 women between the ages of 20-50 were evaluated and the value was found to be 31.4±9.6 cmH_2O (Özdemir, 2015). In a study conducted by Demirtürk (2006), the average value of the pelvic floor muscle strength was found to be 3.93±2.67 kPa. In the study, pelvic floor muscle strength was found to be 11.6±5.9 cmH_2O on average. Considering that the pressure of 12 cmH_2O corresponds to 1.18 kPa, the perineometer values of the women in our study can be classified as low. Since our sampling includes the 20-70 age range, one can say that the perineometer values are low because the number of patients with advanced age is higher than the other studies.

One of the most important factors leading to PFD is pregnancy. Although it is thought that women with PFD have pudendal nerve damage and this damage mostly occurs with vaginal delivery, current studies show that pregnancy, on its own, has adverse effects on the pelvic floor. Mechanical or hormonal effects that occur during pregnancy may affect pelvic support negatively. Over the course of pregnancy, the pelvic floor muscles are constantly exposed to stress and strain as a result of the

pelvic organs pushing down with increasing intra-abdominal pressure due to the uterus growth. This brings out a mechanical condition that adversely affects pelvic support during pregnancy. Additionally, pregnant women were found to have a lower tensile strength of fascia than that of non-pregnant women (Landon et al., 1990). The increased load of the pelvic floor and the relaxant effect of the hormone progesterone are also seen as responsible for the damage during pregnancy (Kudish et al., 2011).

In our study, the decrease in perineometer values observed with advanced age is significant. In previous studies, it has been reported that the most important risk factors for PFD are age and birth (Phillips et al., 2005; Moller, 2000). In a study conducted with 1004 women aged 18-83 years with annual examinations, it was found that the prevalence of pelvic organ prolapse (POP) increased by 40% every 10 years (Mant, 1997). Dietz et al (2005) reported in their study that delivery affects both the hiatus function and size. In symptomatic women who gave birth in the studies of Rortveit and Hunskaar (2004), the puborectalis and pubococcygeus muscles were observed to be partially separated from the arcus tendineus, and women who had this separation were found to be older in comparison with the others, as well as age as an important risk factor for the first pregnancy regardless of the delivery type.

In our study, it was found that the perineometer values of women who gave natural birth normally were significantly lower. Childbirth causes direct myogenic damage, denervation and defects in the endopelvic fascia (Phillips 2005). Vaginal delivery causes trauma to the pelvis major (Baessler 2003). It has been reported that intra-abdominal pressure is provided by the pelvic floor, abdominal wall and diaphragm, and this is possible with the synergy between these three structures (Goldish, 1994; Hilde, 2011; Sigurdardottir, 2011). Tapp (1988) states that vaginal delivery directly damages the pelvic fascial support and causes partial denervation of the pelvic floor and urethra muscles. In the studies, it has been reported that pelvic floor muscles are weakened after childbirth and natural delivery is the most important factor causing damage to the pelvic floor. It has been suggested that the long duration of the second phase of childbirth causes this situation; however, it has also been emphasized that the relationship between the type of childbirth and pelvic floor muscle strength in the long term is still not explained (Baytur, 2005; Phillips, 2005; Dietz, 2005). Lien et al. (2005) placed the inferior perineal and rectal branches of the pudendal nerve from the female cadaver into a computer-aided three-dimensional pelvic floor model, examined how stretched these nerves are while the head descends at birth and found out that these nerves were stretched up to three times or more. It is known that when the nerve innervation in the stretched anal sphincter exceeds the stress threshold by 15%, permanent damage to the appendicular peripheral nerve occurs. The results of the study are significant in that they demonstrate the nerve damage that occurs during vaginal delivery. However, given that this strain is experienced at every childbirth and since the development of dysfunction varies from woman to woman, it suggests that other factors may also be effective in the disease table (Dietz, 2006). It is reported that vaginal delivery, especially in the second phase of delivery, has adverse effects on the autonomic innervation of the bladder and anorectum and the nervous structure of the pelvic organs and pelvic floor, and this change is observed in 80% of women who have had a vaginal delivery. This change was more severe when the second stage of delivery was prolonged and the birth weight was high. This effect was observed even in cases where the cervix was fully dilated and cesarean delivery was performed, for which the protective role of the elective cesarean delivery was mentioned (Dietz, 2005). The studies that have been carried out support the results of our study.

The main reason causing trauma in the pelvic floor can be shown as pregnancy and childbirth. Studies have put forward that the most damage occurs especially at first childbirth. Additionally, the long duration of the second phase of delivery, third-degree perineal tears and high birth weight have adverse effects on the pelvic floor muscles (Özdemir, 2015). In a study by Marshall et al., the muscle strength values of 10 women who had not given birth and 10 women who had given birth once (postnatal 9-10 months) were measured by digital measurement, EMG and perineometer, and it was found that the women who had given birth had significantly lower muscle strength values according to the results of all three measurements (Marshall, 2002). Peschers et al. (1997) evaluated the pelvic

floor muscle strength of a total of 55 women, 25 of whom had one childbirth, 20 who had more than one childbirth and 10 who had cesarean delivery; using palpation, perineometer and perineal ultrasound. The measurements were made between the 36th and 42nd weeks of pregnancy, between the third and eighth days and the sixth-tenth weeks after delivery. The results showed that pelvic floor muscle strength decreased significantly in the third and eighth days after birth in the women who gave natural birth, while there was no change in the cesarean delivery group. In the measurements made with palpation and ultrasound between the sixth and tenth weeks, it was found that the values were not different compared to those before childbirth but according to the perineometer results, the strength values were still low in those that gave birth for the first time. It was stated that cesarean delivery done at the right time did not cause damage to the pelvic floor. It was noted that in deliveries that are expected to occur through the vaginal route and progress in this way if the situations threatening the life of the mother or baby arise, the pelvic floor may still be damaged and neurological injury may occur if the childbirth necessarily occurs through cesarean delivery (Demirtürk, 2006; Peschers, 1997). It was also stated that pelvic floor muscle strength decreased significantly after a vaginal delivery and this situation was not observed in cesarean delivery (Peschers, 1997). In our study, a statistically significant relationship was found between the method of delivery and perineometer values, as well ($p<0.05$).

In our study, it was found that pelvic pressure was low with advanced age and high BMI. Similarly, in other studies, advanced age and high BMI values were found to be risk factors for stress incontinence and pelvic organ prolapse caused by weakness in the pelvic floor muscles. It has been stated that the increase in bladder pressure that obesity causes results in problems with lower urinary system such as difficulty in urination, frequent urination, dysuria, enuresis nocturia and stress incontinence. As the positive relationship between BMI and intra-abdominal pressure was demonstrated with multichannel urodynamics studies, the idea of chronically increased intra-abdominal pressure on the pelvic floor muscles in people with obesity was raised to the foreground (Kapoor et al., 2004; Elia et al., 2001). Viktrup (1992) stated that as the weight increases, chronic strain and weakening occur in the pelvic muscles and nerves, and body mass index (BMI) is significantly higher in stress urinary incontinence. Obesity increases the load on the pelvic floor and leads to disruption in collagen tissues. In women with a BMI of more than 30, incontinence, thus the frequency of surgery at an early age gets higher. Constipation is also another factor that increases intra-abdominal pressure. To perform defecation, a perineal descent caused by excessive strain leads to tension in the pudendal nerve and the denervation of the pelvic floor. It has been observed that POP is 2.51 times more in women whose BMI is between 25-30 and 2.56 times more in women whose BMI is over 30 (Bidmead, 1998; Meyer, 1998). Similarly, Demirci et al. reported that women whose BMI is 26 and above have a higher risk for surgery due to prolapse than those whose BMI is below 26. In the light of other studies, our study also demonstrated that the perineometer values in women with BMI>30 were very low, while those with BMI 25-<30 had low values.

In our study, pelvic floor (PF) strength was found to be significantly lower in menopausal women. Especially in the menopausal period, PFD is expected to occur as the estrogen withdrawal with its protective effect takes place. It has been determined that atrophic changes begin or accelerate in the fascia and ligaments, pelvic relaxation conditions of different types and clinical features occur depending on the anatomical regions where the supportive tissue weakens, as the tonic effect of ovarian hormones disappears in the menopause period (Tanriverdi, 2004). It has also been reported that decreased urethral vascularity leads to low urethral baseline pressure of abnormally smooth and striated muscle activity and abnormal stress response during the menopausal period (Semmens, 1982).

Our study has found a statistically significant correlation between the employment status and perineometer values ($p<0.05$). One can say that this is because working women are more socialized and connected with social support systems. Women may increase their level of knowledge and awareness on this matter by meeting with other women in their workplaces. Similarly, a statistically significant result was found between the educational status of women and perineometer values. Since

women prefer cesarean delivery as the education level increases, PFD may be observed less. Additionally, a statistically significant result was found when the women's data of place of residence and perineometer values were compared. In our study, it was found that the correlation between the methods of contraception and perineometer values was statistically significant ($p<0.05$). No previous research has been found focusing on this matter and it is a first in this regard in Turkey. To this respect, one can examine the relationship between education, place of residence, employment status, contraceptive methods and perineometer values in future studies.

In studies, there are not many studies on risk factors affecting the pelvic floor muscle strength, and the sampling size of our research is a basis for further research by examining a wide range of variables that may affect pelvic floor muscle strength. Therefore, it is a must to raise awareness of the risk factors for pelvic floor muscles that adversely affect people's quality of life with their physical, social, economic and psychological impacts, determine the factors that decrease the pelvic floor muscle strength, work to decrease or eliminate these factors and raise people's health levels and quality of life.

5. CONCLUSION

Starting from the early stages of life, arguments on the potential protection measures for the pelvic floor should be developed, women should be educated by the healthcare personnel who are informed about this matter, exercise programs for pelvic floor muscle strength should be taught, and the ground should be established by determining the pelvic floor muscle strength for further research.

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