

Walking Patterns According to the Room of Shoes Sizes⁺

- Focusing on Female Collegians on Busan -

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Abstract

With 100 collegians residing in Busan, a shoes wearing survey was held. Out of the subjects, 50 women collegians showing some interest in fashion sneakers were chosen to reveal the effects of shoes size changes on walking patterns and wearing sense. This study focused on the fitness of sneakers produced the following results:

1. Survey Results of Shoes Wearing

The subjects had some room in wearing sneakers or athletic shoes, including 20~30mm (33%). Just 25% of the subjects reported about the experience of falling, and 67.6% had difficulty walking on downhills. 50% felt feet fatigue difference when wearing fitting and unfitting shoes.

2. Analysis of Walking Patterns & Survey Results of Wearing Sense

No significance was found among shoes sizes in left and right step angles. Step width measurement revealed no significance among shoes sizes. Significance ($p \leq .05$) existed among shoes sizes in steps and strides. Significance ($p \leq .001$) was noticed among shoes sizes in wearing sense.

Key words: walking patterns, step angle, step width, steps and strides, room of shoes sizes

I. Introduction

Walking is human basic movement. As the most common movement to move from one point to another point, it is a task learned almost unconsciously. It is complex movement worked by about 100 muscles as well as the joints of upper and lower body(Jeong Mi-ra,1995).

Human feet make possible standing erect and play an important role in walking. With peculiar movement types, feet have structural and functional characteristics. They passively support

weight when movement is stopped, and actively propel movement when walking. So, when feet are weak, human structural balance is broken and postural disorder and functional troubles follow(Choe Seon-heui,1998).

In addition, walking patterns can be greatly different according to individual physical characteristics and psychological characteristics like social lifestyle and consciousness. As good walking increases health and bad walking causes disorderly human structure, the importance of walking has been stressed in most

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preceding research.

Shoes affect walking movement a lot. The choice of right shoes is essential for the health of our feet. Unfitting shoes deform foot bones, make bad posture, and trigger diverse diseases. As 85% of foot disorders come from wrong shoes, footwear should be carefully chosen(Yoo Hyun, 1990).

In this modern age of total fashion, shoes can be said to complete fashion. Big shoes were recently in vogue among the youths. In this respect, it will be a meaningful research to know the effects of the shoes unfitting one's foot size on walking patterns.

Compared with the research in the kinetic analysis of walking, walking types, and shoes sizes, the relationships between walking patterns and shoes sizes have rarely been covered. The present paper, therefore, aims to analyze the walking patterns according to some room of shoes sizes and reveal the significance of choosing right shoes and making a good walking habit.

The concrete aims are as follows:

1. Analyze the problems with wearing fashion shoes through the survey of shoes wearing.
2. Analyze the walking patterns according to the room of fashion shoes by way of footprints and evaluate the feeling of wearing according to the room of fashion shoes.
3. Based on these results, the harm of the shoes with low suitability is informed to the customers, while they may be used as the basic data for shoe model design and manufacturing

II. Research Methods & Procedure

1. Shoes Wearing Survey

1) Subjects & Period

From September 10 through 30, 2003, 130 male and female adults in their 20s were given a questionnaire. Among the retrieved survey copies, 30 were excluded for incomplete responses and insufficient data, and 100 were chosen for analysis here.

2) Contents

All 51 items were divided into several sections-demographic (7), lifestyle (4: researcher), fashion image (8: Yi Ho-jeong 1999), fashion consciousness and purchase (10: Pak Eun-heui 1999), shoes purchase and wearing (12: Cheon Jong-suk & Choe Seon-heui 2000), and shoes wearing disorders and walking patterns (10: Kim Se-na 2000). The questionnaire used here was a little amended and compensated from that of the preceding investigators.

2. Walking Experiments

1) Subjects

The subjects were 50 female collegians in their twenties who favor fashion sneakers above anything else. The physical characteristics of the subjects are seen in <Table 1>.

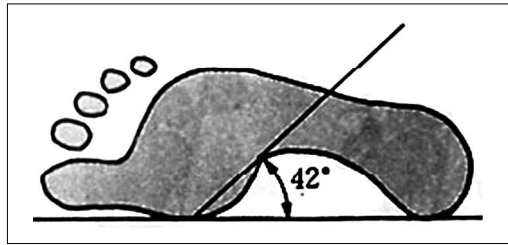
2) Date & Place

Preparatory and main experiments were held from July 6 through August 14, 2002 in the Laboratory of Human Clothing Engineering at Dong-A University, Busan, Korea.

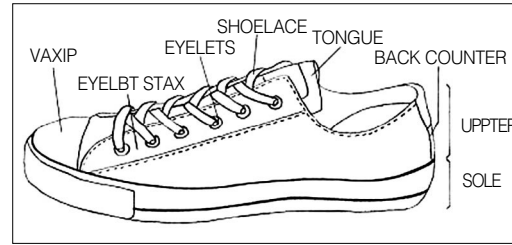
<Table 1> Physical characteristics of the subjects

Item	Year (Year)	Height (cm)	Weight (kg)	Foot Length(cm)	step angle (°)		step width (cm)	steps and strides(cm)	C.F.P.A.* (°)
					Right	Left			
Mean	22.80	162.71	51.70	229.54	9.59	10.56	4.98	61.77	44.38
S.D.	2.29	4.57	4.89	6.78	5.14	4.64	2.46	5.45	5.78

* C.F.P.A.(Clarke Foot Print Angle)value>42° : Nomal



<Fig. 1> Measurement method of C.F.P.A.



<Fig. 2> Experimental shoes

3) Experimental Shoes

The shoes used for the experiments were sneakers, worn most in the questionnaire. Two types of sizes were selected: A (room of 10mm, as fitting size suggested by Jo Maeng-seop, 1985), B (room of 30mm between foot and shoes sizes based on survey result). The appearance and characteristics of the shoes are seen in <Fig. 2> and <Table 2>.

4) Experimental Methods

(1) Experimental Order

a. The prepared socks and shoes(A type, B type) were given to the subjects before the experiment. For 20 minutes, they were allowed to practice usual walking on the prepared sheets of paper (15m × 0.92m).

b. Wearing the shoes absorbing ink, the subjects were asked to walk as naturally as possible on the paper toward the front target. An

<Table 2> Characteristics of experimental shoes

Items Size (mm)	Weight (g)	Sole	Uppers	Attachment Method	Peeling Intensity (kg)
235	558	Rubber, polyurethane	Synthetic leather, cotton	Pressing	≥ 2.5
240	576	"	"	"	"
245	590	"	"	"	"
250	612	"	"	"	"
255	632	"	"	"	"
260	640	"	"	"	"
265	650	"	"	"	"
270	662	"	"	"	"

assistant separated each subject from other waiting subjects to minimize the mental effects by the surrounding situation.

c. One subject tested A type first and it tested B type in after that.

(2) Measurement Methods of Walking Patterns

Based on Yoo Hyun's research (1990), step angles, step width, steps, and strides were measured.

a. As <Fig. 3> indicates, (-) is when the inside contact line of the shoes and the feet angle go inside, and (+) is when they go outside.

b. As seen in <Fig. 4>, the distance between the inside contact lines of the shoes is measured: (+) when step width doesn't overlap, (-) when step width overlaps.

c. As in <Fig. 5>, a step is the distance from one heel to the other heel, and a stride is that from one heel to the same heel.

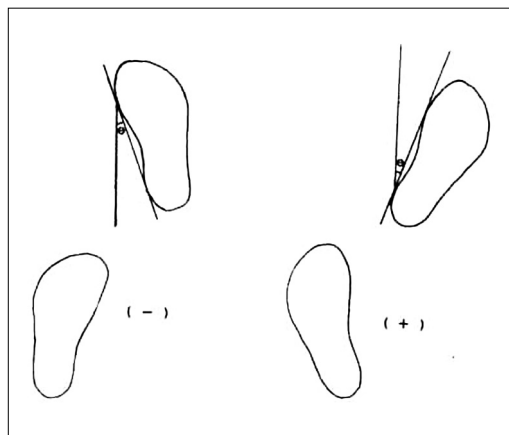
(3) Investigation of Wearing Sense

In order to measure the sense of wearing, 4-point scales were held according to Yoo Hyun's study (1991): 1 (very uncomfortable), 2

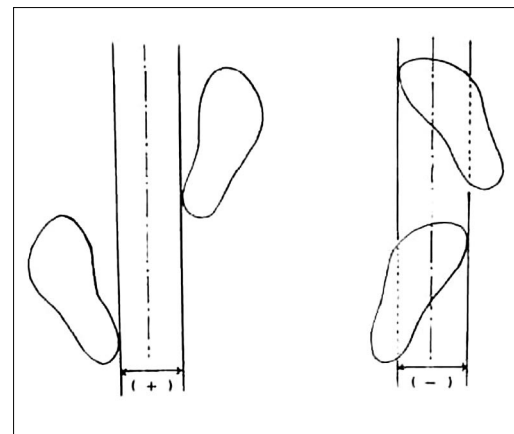
(uncomfortable), 3 (comfortable), 4 (very comfortable).

3. Data Processing

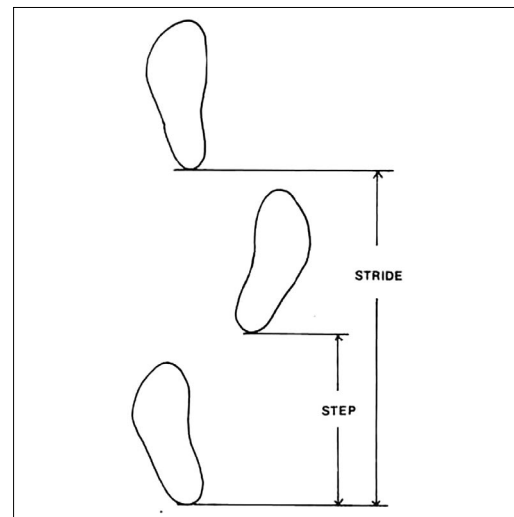
The data here went through the SPSS/Win (ver 9.0) program. Percentage was employed in the survey of shoes wearing, while paired t-test was



<Fig. 3> Measurement of step angles



<Fig. 4> Measurement of step width



<Fig. 5> Measurement of steps and strides

given to verify the significance levels of walking patterns and wearing sense.

III. Results & Discussion

1. Survey of Shoes Wearing

1) Reality of Shoes Purchase & Wearing

(1) Purchase Places & Considerations

<Table 3> sums up the considerations and places of purchase. Design (74%) was most considered, followed by wearing sense (14%) and price (5%). In purchase places, shoes speciality stores (76%) were followed by department stores (10%), clothing shops (10%), and grand discount stores (5%).

(2) Favorite Trademarks

Bonded leather shoes (75%) and Kumgang Shoes (7%) were most favored. Bonded goods (48%), Nike (19%), and Adidas (14%) were the order of sneakers. Therefore, rather cheap bonded shoes seem to be more popular than expensive brand goods.

<Table 3> Considerations and places in shoes purchase (n=100)

Items		Frequency (n)
Purchase Considerations	Design	74
	Price	5
	Color	2
	Material	0
	Wearing sense	14
	Brand	1
	Fashion	3
	Size	1
Purchase Places	Department stores	10
	Shoes speciality stores	76
	Traditional markets	0
	Clothing shops	10
	Grand discount stores	4
Total		100

(3) Reality of Shoes Purchase & Wearing

The analysis results of the reality of shoes wearing and purchase prices are seen in <Table 4>.

The shoes purchase price was mostly 50,000~100,000 won (48%), while sneakers stood at the prices of 30,000~50,000 won (35%) and less than 30,000 won (33%). As a result, the subjects were found to like bonded athletic shoes of reasonably cheap prices.

<Table 4> Reality of shoes purchase & wearing

(n=100)

Items	Frequency (n)		Items	Frequency (n)	
	Shoes	Sneakers			
Purchase Price	<30,000 won	15	Wearing Time	<3 hours	0
	30,000~50,000 won	26		3~6 hours	5
	50,000~100,000 won	48		6~9 hours	34
	>100,000 won	11		>9 hours	61
Shoes Room	No room	26	Walking Time	<3 hours	27
	5~10mm	34		3~6 hours	53
	10~15mm	13		6~9 hours	14
	15~20mm	10		>9 hours	6
	20~30mm	17		Total	100

Shoes wearing time was 9 or more hours (61%), 6~9 hours (34%), and 3~6 hours (5%). Shoes walking time was in the order of 3~6 hours (53%), less than 3 hours (27%), 6~9 hours (14%), and 9 or more hours (6%).

The room of the shoes was 5~10mm (34%), none (26%), and 20~30mm (17%). That of the sneakers was 20~30mm (33%), 5~10mm (23%), and 10~15mm (22%). So, sneakers are worn with more room than shoes.

(4) Reasons for Wearing Bigger Size Shoes

Among the reasons for wearing bigger size shoes than one's foot size were comfort (of putting on and taking off) (46%), match with clothes (18%), and personal feet characteristics (16%).

2) Reality of Shoes Wearing Disorders & Walking Patterns

For the subjects with the experience of wearing the shoes bigger by 10mm or more, shoes wearing disorders and the effects on walking patterns were investigated.

<Table 5> Reasons for wearing bigger size shoes

Reasons	Frequency
Design	11
Comfort (putting-on/ taking-off)	46
Fashion	9
Match with clothes	18
Unity with others	0
Individual feet characteristics	6
Total	100

(1) Experience, Causes & Contents of Disorders

The disorder experience, causes, and contents are analyzed in <Table 6>. Among the 68 subjects who have worn the 10mm-or-more-bigger shoes, 92.6% reported about the experience of discomfort. Only 7.4% told they had no such feeling.

The causes were in the order of unnatural walking (30.2%), getting removed (27.9%), inadequate sizes (26.7%), stiff material (10.5%), and improper heels (4.7%). Thus, unfitting sizes cause unnatural walking patterns as well as shoes removal.

Among physical disorders, leg fatigue (55.9%)

<Table 6> Disorder experience, causes & contents



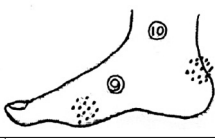
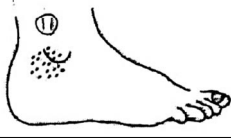
Items		Frequency (n)	Percentage (%)	Items		Frequency (n)	Percentage (%)	
Dis-comfort Experience	Yes	63	92.6	Physical Disorders	Leg fatigue	38	55.9	
	No	5	7.4		Overall fatigue	8	11.7	
Total					Total			
Total					Total			
Causes*	Unfitting heel	4	4.7	Foot Disorders*	Toe pain	23	25	
	Stiff material	9	10.5		Feet pushing	19	20.7	
	Unfitting size	23	26.7		Sole pain	27	29.3	
	Unnatural walking	26	30.2		Ankle pain	18	19.6	
	Shoes removal	24	27.9		Numb Feet	5	5.4	
Total					Total			

*: Multiple choices

was great. But aching in the knees (16.2%) and the waist (16.2%) as well as overall fatigue (11.7%) were also reported. Foot-related

disorders turned out in the order of sole pain (29.3%), toe pain (25.0%), feet pushing (20.7%), ankle pain (19.6%), and foot numbness (5.4%).

<Table 7> Foot distortion & diseases

Items		Part	Frequency (n)	Percentage (%)	
Foot Distortion & Disease Parts*	Instep		①	6	5.94
			②	3	2.98
			③	23	22.8
	Sole		④	7	6.93
			⑤	14	13.86
			⑥	12	11.9
			⑦	3	2.98
	Inside		⑨	3	2.98
			⑩	9	8.91
	Outside		⑪	8	7.92
	Total			101	100.0
Foot Diseases*	Toe distortion		26	28.9	
	Toenail distortion		8	8.9	
	Corns		4	4.4	
	Dropsy		7	7.8	
	Eczema		2	2.2	
	Athlete's foot		5	5.6	
	Calluses		38	42.2	
Total			90	100.0	

*: Multiple choices

In detail, as Table 7 shows, the distortion of the 5th toe (part ③: 22.8%) was the greatest, followed by three similar parts (⑤, ⑥, ⑧). Such foot-concerned diseases as a callus (42.2%), deformed toes (28.8%), disfigured nails (8.9%), dropsy (7.8%), and athlete's foot (5.6%) appeared.

(2) Walking Patterns & Problems

<Table 8> analyzes the walking patterns and problems coming from wearing bigger size shoes. Those with the experience of falling amounted to 25%. Difficult places for walking (or easy places for falling) were in the order of downhill (67.6%), stairs (22%), even roads (5.9%), and uphill (4.4%). This is owing to the tendency of feet pushing to the front or the shoe toe touching the edge of stairs.

As shown in <Table 8>, feet fatigue difference was felt by 50% when wearing fitting and unfitting (or bigger) shoes. 66.2% felt walking pattern changes when bigger size shoes were worn, while the outward (in the shape of reversed ㄱ) pattern (55.9%) was the most changed pattern.

Therefore, the subjects revealed that fashionability is the key factor in the selection of

shoes. The room of 20~30mm was favored as for sneakers owing to the good feeling of wearing. Those with the experience of wearing the shoes bigger by 10mm or more had some discomfort experience, especially feeling difficulty in walking downhill or stairs. The subjects also felt the changes in their walking patterns by wearing bigger size shoes.

2. Walking Experiments

1) Walking Pattern Analysis

The significant differences of walking patterns according to shoes sizes are seen in <Table 9>. There was no significance in step angles and step width. With some significance in steps and strides, they were affected by shoes sizes.

(1) Step Angles

The changes of step angles according to shoes sizes are shown in <Fig. 6>. With no significance though, the right foot had more out-toeing than the left foot. Somewhat agreeing with Cavanagh et al. (1985), this seems to be due to the high turning of the right foot.

<Table 8> Walking patterns & problems

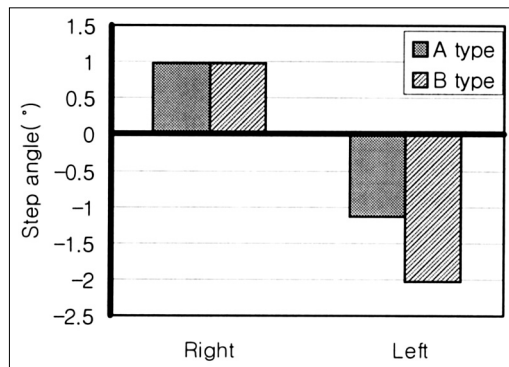
(n=68)

Items		Frequency (n)	Percentage (%)	Items		Frequency (n)	Percentage (%)
Falling Experience	Yes	17	25	Walking Pattern Changes	Yes	45	66.2
	No	51	75		No	7	10.3
Difficult for Walking	Flatland	4	5.9		Etc	16	23.5
	Downhills	46	67.7	Changed Walking Pattern	Normal	21	30.9
	Uphills	3	4.4		Outward	38	55.9
Stairs	15	22.0	Inward		7	10.2	
Feet Fatigue	Yes	34	50.0		Parallel	1	1.5
	No	3	4.4	Etc	1	1.5	
	Etc	31	45.6	Total		68	100.0

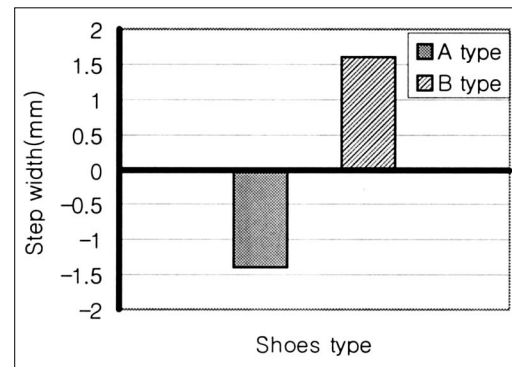
<Table 9> T-test results of walking patterns according to the room of shoes sizes

Items	Types	Type A		Type B		p-value
		Mean	SD	Mean	SD	
Step angles	Left	-1.14	4.33	-2.02	4.33	0.970
	Right	0.98	4.73	0.99	4.08	0.526
Step width (mm)		-1.40	26.70	1.60	24.50	0.803
Steps (cm)		63.36	5.99	64.66	4.80	0.049*
Strides (cm)		127.20	13.21	130.37	10.32	0.028*

(*: $p \leq .05$)



<Fig. 6> Changes of left/right step angles according to the room of shoes sizes



<Fig. 7> Changes of step width following the room of shoes sizes

Step angles had two types of walking patterns in the subjects, in-toeing (44%) and out-toeing (20%). So the subjects need to be subclassified for in-depth research according to the shapes of step angles.

(2) Step Width

The changes of step width following shoes sizes are illustrated in <Fig. 7> 官畑(1988) defined the most efficient places of the feet as “putting both feet forward in the center with the minimum swaying of body weight.” According to the analysis of these experiments here, mean values approached those of efficient step width. Type B was bigger than Type A on the average, but not that big.

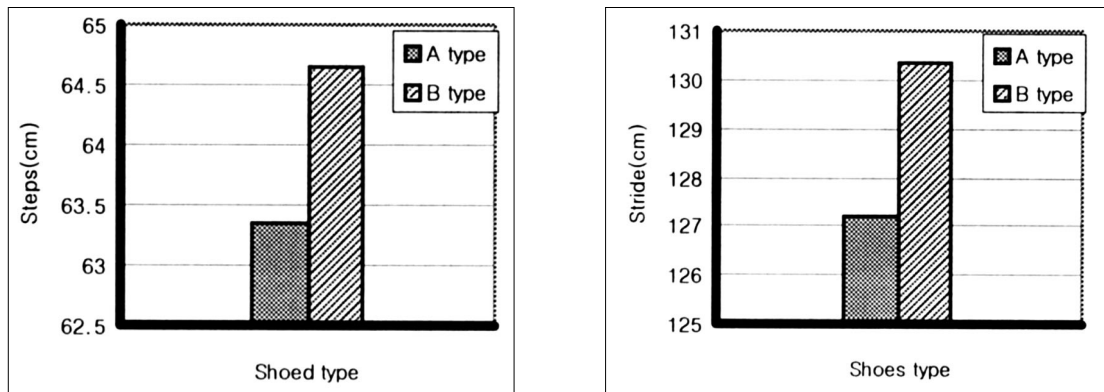
Well (1988) reports that most collegians with

improper walking patterns were either lacking self-confidence or extremely introvert. So too big- or too small-sized shoes are not desirable in both physical and mental aspects. This should be considered without fail in shoes purchase.

(3) Steps & Strides

<Fig. 8> portrays the changes of steps and strides according to the room of shoes sizes. Steps and strides grew bigger in Type-B shoes than in Type-A shoes, to cause unnatural walking as a result. Wearing bigger size shoes triggers the progress of flat feet and other serious problems in human structure. Functions, not fashionability, should be considered first in the selection of shoes sizes.

As feet play a role of maintaining weight and



<Fig. 8> Changes of steps and strides following the room of shoes sizes

holding the center in body movement. In wearing bigger-sized shoes, a tendency of physical movement to go forward can appear. As found in the analysis of the questionnaire, walking difficulty and falling are observed in downhills. Also, heel dragging in Type-B shoes appears to be related with steps and strides.

2) Wearing Sense Survey

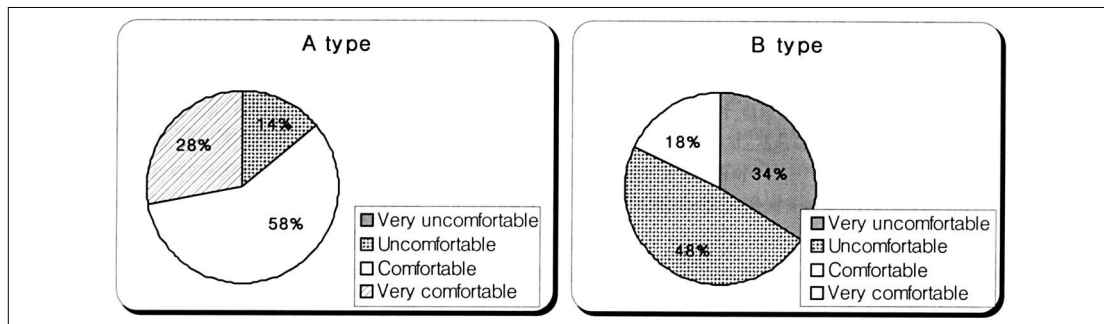
According to the T-test analysis of wearing sense through the 4-point scale, significance ($p \leq 0.001$) was admitted between the two types of shoes.

<Fig. 9> shows the changes and responses of wearing sense according to the room of shoes

sizes. In Type A, “very comfortable” and “comfortable” amounted to 86%, whereas these two items reached 18% in Type B. Therefore, as Jo Maeng-seop (1985) held, the room of 10mm in sneakers makes the greatest sense of comfort. So wearing proper size shoes can have a positive effect on the satisfactory sense of wearing and mental security.

IV. Conclusion

With 100 collegians residing in Busan, a shoes wearing survey was held. Out of the subjects, 50 women collegians showing some interest in



<Fig. 9> Changes of wearing sense according to shoes sizes

fashion sneakers were chosen to reveal the effects of shoes size changes on walking patterns and wearing sense. This study focused on the fitness of sneakers produced the following results:

1. Survey Results of Shoes Wearing

1. The subjects had some room in wearing sneakers or athletic shoes, including 20~30mm (33%).

2. Most subjects talked about uncomfortable experience as a result of wearing big-sized shoes. Leg fatigue (55.9%) was the most common among physical disorders, while all the parts of the feet had similar disorders.

3. Just 25% of the subjects reported about the experience of falling, and 67.6% had difficulty walking on downhills. 50% felt feet fatigue difference when wearing fitting and unfitting shoes.

4. About 2/3 (66.2%) felt walking pattern changes when bigger size shoes were worn, while the outward (in the shape of reversed λ) pattern (55.9%) was the most changed one.

2. Analysis of Walking Patterns & Survey Results of Wearing Sense

1. No significance was found among shoes sizes in left and right step angles.

2. Step width measurement revealed no significance among shoes sizes.

3. Significance ($p \leq .05$) existed among shoes sizes in steps and strides.

4. Significance ($p \leq .001$) was noticed among shoes sizes in wearing sense.

In sum, the factors of steps and strides were

found to have a lot to do with the suitability of feet and shoes as well as shoes sizes. So, wearing bigger-sized shoes than one's feet causes unnatural walking, falling, foot distortion, and other disorders.

In addition, bigger steps and strides can bring about easily-increasing feet fatigue and inefficient walking. The sense of wearing is affected a lot by shoes sizes, while more discomfort was felt in wearing big size shoes.

Selecting shoes focused on fashion can have a negative influence on walking and result in feet distortion. That's why it is of vital importance to wear proper shoes with a focus on functionalism. As the basic data for right walking patterns, the current research is expected to serve as an occasion for emphasizing the importance of healthy feet management and proper walking habits.

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