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Ergonomic Assessment for Manual Materials Handling of Livestock Feed by Elderly Farmers in Korea

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Objective: The purpose of the study is to evaluate appropriate weight for aged farmers in manually handling livestock feed in bags using ergonomic methods.

Background: In the livestock industry in South Korea, despite the trend of aging of labor manpower, heavy items are still manually handled in many farms. In particular, among stockbreeding works, the handling of feed in bags weighing 25~30kg is reported as a cause of frequent injuries and musculoskeletal system diseases. However, studies on the standard for recommended weight allowed considering the physical characteristics of aged farmers older than 60 years with greatly decreased physical strength and muscle strength are insufficient.

Method: To evaluate appropriate weight for handling of heavy livestock feed in bags, physical techniques for measuring recognized levels of physical work loads, the NLE (NIOSH lifting equation) a method that is an observation type technique, and an ergonomic modeling technique to predict compressive force imposed on L5/S1 were used. Subjects who participated in the experiment were organized into two groups of males/females with mean age exceeding 60 years, and lifting tasks were evaluated for nine weight levels.

Results: Based on the results of psychophysical measurement, females showed a tendency of more drastic increases compared to males when weight was over 19kg. The results of estimation of regression models for the weight, 18.0 kg (r^2=0.97) and 15.3kg (r^2=0.97) were evaluated as stable load for males and females, respectively. In addition, both the observation type evaluation and ergonomic model evaluation showed stable loads in a range of 15~18kg.

Conclusion: Given the results of the study, the weight of the feed in bags currently distributed to farms can become a cause of not only overexertion but also farm work related disasters such as musculoskeletal disorders and safety accidents. Providing livestock feed in bags weighing not more than 19kg for aged farmers is judged desirable, and managerial improvement for this matter is considered necessary.

Application: The results of the present study can be utilized as useful data for institutional improvement of the weight of livestock feed in bags.

Keywords: Manual material handling, Psychophysical approach, Biomechanical technique, Livestock work, Elderly farmers

1. Introduction

The number of livestock has sharply increased, and livestock work has hugely improved, due to farm facility modernization and automation in the Korea's livestock

industry. The livestock industry and relevant industries are very important in the national economy, and have quantitatively grown (Kim et al., 2014). However, livestock farmers are recently on the decline, and the aging of labor force is severely deepening. As a result of aging ratio survey indicating the farm ratio with farmers aged 65 or older among total agricultural farms, the livestock field took up 44.3%, which was 7.5% higher than the farming field of 36.8%. This implies that the aging of the livestock farming field is relatively more serious (KOSTAT, 2013). Although, mechanization and automation have been carried out in farming work requiring much labor force, the manual materials handling farming work using labor as a power source still exists.

Carrying livestock feed in bags is a typical case of manual materials handling (MMH) by human's labor in the livestock industry. The weight of the livestock feed in bags generally distributed in farms is 25~30kg per bag, and is unsuitable for the physical characteristics of elderly farmers and female farmers. Therefore, frequent injuries and safety accidents (i.e. lumbar pain, injuries to spine) are caused (Drury and Pizatella, 1983; Mital and Asfour, 1983). The representative diseases developing to farmers, namely, musculoskeletal disorders have been identified to have high relevance with MMH (Fathallah, 2010). The musculoskeletal disorders function as a more dangerous factor to elderly farmers aged 60 or older, whose physical strength and muscle power decrease hugely, and thus it is important to prevent musculoskeletal disorders.

Looking at domestic and international guidelines and laws and regulations related with MMH, 25kg for males and 15kg for females are recommended for one-off work, and 10kg and 5kg for males and females are recommended, respectively, for repetitive work in case of 50 years old or over according to a special action on recommended standard of allowed weight and manual materials lifting task by KOSHA (2012). The NIOSH (National Institute for Occupational Safety & Health) presented safety limit protection level and 23kg as maximum weight that can be accepted by 90% of adult males and females in 1993 (John et al., 2007). IOSHIC (International Occupational Safety & Health Information Center) presents recommended standard for manual materials handling for aged 51 or older: 16kg for males and 10kg for females. According to Australian Job Health Safety Law, workers should not handle alone an object exceeding 16kg, bans exceeding 240kg handling for any type of work, and prohibits handling of objects including bags for 15 minutes. EN sets forth the safety limit weight of lifting task as 25kg, which is the safety standard including 99% of male workers and 72~75% of female workers. The ISO Standard (ISO 11228-1) presents maximum weight of 25kg that 95% and 70% of adult males and females can lift, respectively (ISO, 2003). The ILO (International Labor Organization) presents 16kg for males and 10kg for females as recommended standard for workers aged 50 or older. As such, the weight of livestock feed in bags distributed to farms is judged to exceed elderly farmers' physical ability, based on the domestic MMH recommended standard. Table 1 shows the recommended values of ILO and domestic and international recommended standards for workers aged 50 or older.

Table 1. Recommended standards for heavy weight handling of workers (aged 50 or older)

Classification	Work condition	Male (kg)	Female (kg)
ILO	-	13.6	9.8
Korea & Japan	Temporary (2 times/hour)	25	15
	Continuously (3times/hour or more)	10	5
U.S	-	16	10

Looking at law on packaging dimensions of livestock feed in bags of Korea, the law specifies the details of design and weight marking in relation with paper bag packaging and ton bag packaging (MAFRA, 2014). However, the law does not include guidelines and regulations on limit weight per packaging unit. In reality, there is no recommendation of allowed weight for livestock feed

in bags. Therefore, aged farmers conduct MMH in line with the weight of livestock feed in bags distributed, and thus they are conjectured to be exposed to the factor of musculoskeletal disorders. In this regard, standard presentation through objective evaluation, and managerial and institutional improvement efforts are required. This study reviews differences between males and females, and evaluates proper weight level using ergonomic techniques on lifting task that is carried out at livestock feed handling sites.

2. Methods

2.1 Evaluation method

This study used a psychophysical technique, an observation model technique and a biomechanical technique mainly used in the ergonomics field to evaluate lifting tasks.

As a psychophysical technique, this study used Borg's CR10 scale. Borg REP (rating of perceived exertion) index was developed by approaching the physiological fatigue of human body psychologically, and is widely used to measure physical work load and physical activity strength nowadays (Marriott and Lamb, 1996; Sanders and McCormick, 1992; Kroemer et al., 1990). As for Borg's CR10 scale, Scale 1 (very light) means the level that work load is not hard, although a healthy person works as he/she desires to for a long time. Scale 3 (moderate) means a healthy person does not feel the work is especially hard, and there is no problem to work for eight hours. Scale 5 (hard) means a healthy person feels physically hard, and fatigue. Also, Scale 3 is proposed as safe load psychophysically (Borg, 1993).

In the observation model technique, NLE (NIOSH lifting equation) can be applied to lifting task analysis by calculating RWL (recommended weight limit) and LI (lifting index) (NIOSH, 1981). NLE was recently applied to harvest lifting tasks as part of farming work improvement in Korea (RDA, 2010), and is also mainly applied to diverse types of lifting tasks in industrial sites. NIOSH classifies as follows: safe work, if LI value is within 1.0, and dangerous work to some workers if the value is 1.0~2.0. Also, dangerous work to many workers, if LI value is 2.0~3.0, and dangerous work to most workers, if the value exceeds 3.0 (NIOSH, 1994). Wang et al. (1998) reported: when LI value exceeds 1.7~2.0, he regarded it as the point in time of lumbar pain occurrence in the NLE related study.

For the biomechanical human body work load evaluation, the biomechanical modeling technique was used to predict compressive force value occurring to L5/S1. To this end, this study used the 3DSSPP (3D Static Strength Prediction Program) of the University of Michigan. NIOSH classifies lifting load, based on 3400N as action limit, which is biomechanical standard, and 6400N as maximum allowed limit, according to L5/S1 compressive force value (NIOSH, 1991). If the value is more than 4500N, it is known that lumbar pain occurrence rate increases to more than 10% (Chaffin and Park, 1973).

Figure 1 shows the examples of Borg's CR-10 scale and 3DSSP that were applied in this study.

2.2 Subjects

The subjects of the experiment had no musculoskeletal disorders and neurological sign in the past and present, and had no experience of treatment for lumbar pain at hospitals within the most recent six months. The subjects could perform normal activities at the time of conducting the experiment. The mean age of the subjects were 64.6 for males and 61.1 for females, and the subjects consisted of two groups (male group with seven males, and female group with seven females). Table 2 shows the subjects' mean age, height and weight.

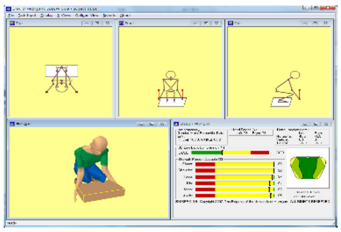
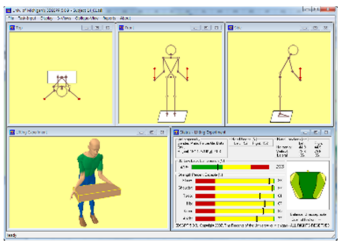
RPE (Rating of perceived exertion)		3D Static Strength program
0	Nothing at all	
0.5	Very, very light	
1	Very light	
2	Fairly light	
3	Moderate	
4	Somewhat hard	Start posture
5	Hard	
6		
7	Very hard	
8		
9		
10	Very, very hard	End posture

Figure 1. Borg's CR-10 scale and 3D static strength prediction program

Table 2. Characteristics of subjects

Gender	Age (year)	Height (cm)	Weight (kg)
Male	64.8 (±SD: 0.5)	164.1 (±SD: 5.8)	71.3 (±SD: 8.6)
Female	61.1 (±SD: 3.7)	158.1 (±SD: 3.0)	66.6 (±SD: 7.2)

*SD: Standard Deviation

2.3 Apparatus

This study selected livestock feed in bags (width 100cm×length 80cm×height 20cm) distributed in the livestock farm sites as samples used for lifting tasks in this study. This study adjusted the weight of the content, while retaining the existing packaging dimensions and shape. The samples' weight consisted of nine levels (7kg, 10kg, 13kg, 16kg, 19kg, 22kg, 25kg, 28kg, 31kg) to include ILO recommended minimum weight of 10kg for MMH, 25kg of recommended ISO (ISO 11228-1) weight, which is maximum weight that 95% and 70% of adult males females can lift, respectively, and the maximum weight of 30kg handled in the actual livestock breeding sites. For the worktable for lifting task, this study used a desk (width 150cm×length 80×height 73cm). Concerning the anthropometric measurement devices for the subjects, this study used a height/weight measuring device (SH-9600A-1), a tape measure and goniometer.

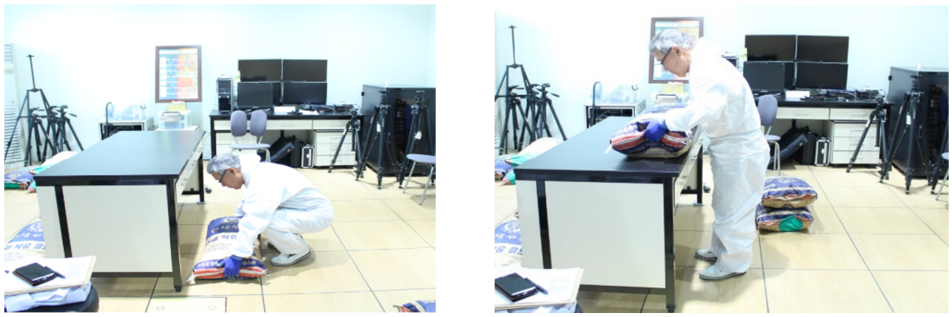
2.4 Experimental design

The independent variables in the experiment were gender and weight, and each was repeatedly measured seven times per lifting task. Total number of the experiment was 882 (2×7×9×7=882). Limited variables were the same dimensions of the same

livestock feed in bag, worktable height, and posture through which one can safely lift. Dependent variables were the awareness level of physical work load, and it was immediately measured, after one time of lifting task. The subjects did not know the presented weight, and lifting order of those bags was made randomly. To minimize measurement pollution, due to fatigue recovery or weakening physical muscular strength, the experiment offered 10-minute break so that the subjects could sufficiently recover energy, after one time of lifting task.

2.5 Experimental procedure

Before the experiment, an explanation on experiment method and purpose and cautions was offered. Also, this study measured the anthropometric measurement (i.e. age, height, weight) of the subjects who agreed to participate in the experiment, filmed NLE upon preliminary test before the experiment, and the start posture (before lifting) and end posture (at final target point) for the data to apply 3DSSPP evaluation with a camcorder, and conducted anthropometric measurement. This experiment let the subjects select stable foot and hand-gripping locations to lift an object. After each lifting task, the awareness degree of physical work load was checked. Figure 2 shows the image of the experiment.



Start posture End posture

Figure 2. Experiment of lifting tasks

3. Results and Discussion

3.1 Psychophysical evaluation

As a result of Borg's CR10 Scale measurement, physical work load awareness showed a statistically significant difference in relation with independent variables (p-value<0.0001) (Table 3), and also interaction was revealed according to gender and weight level of an object (p-value<0.0001).

Table 3. Results of ANOVAs of physical workload awareness

Source	Sum of squares	DF	Mean square	F-value	Prob. > F
Corrected model	931.41	17	54.79	58.30	<.0001*
Intercept	1870.72	1	1870.72	1990.49	<.0001*

Table 3. Results of ANOVAs of physical workload awareness (Continued)

Source	Sum of squares	DF	Mean square	*F*-value	Prob. > F
Gender	40.37	1	40.37	42.95	<.0001*
Weight	854.69	8	106.84	113.68	<.0001*
Gender*Weight	36.35	8	4.54	4.84	<.0001*
Error	101.50	108			
Total	2903.63	126			

Signification at a level: *0.0001

Table 4 shows the interaction analysis results, according to gender and weight level of an object. There was no difference between males and females at the level of 7kg, and significant difference was not shown to the males at the level of 10~13kg. However, significant difference was revealed to the females. Significant difference was not revealed to the males in the case of 16~22kg, and to the males in the case of 13~19kg of weight level. Rapid increase was shown at 31kg level in the males, but it was revealed at more than 22kg to the females. Namely, physical work load difference between males and females showed gradual uptrend, as the weight level increased on the basis of 19kg. As a result of regression model estimation on psychophysical and physical work load, it was 17.96kg (r^2=0.97) for the males, and 15.33kg (r^2=0.99) for the females at Scale 3 (load level the males and females did not feel especially hard). As such, according to psychophysical evaluation results, it was identified that females felt physical work load went up rapidly at the level of more than 19kg, compared to the males. Figure 3 shows the relationship between the weight level of an object and physical work load awareness.

Table 4. Results of interaction effects in ANOVA

Interaction	Mean	SD	Subset	*F*-value	Prob. > F
Male*7kg	0.00	0.00	A	52.28	<.0001*
Female*7kg	0.71	0.76	A		
Male*10kg	1.31	1.23	B		
Female*10kg	0.00	0.00	B		
Male*13kg	3.18	0.50	B		
Female*13kg	3.31	1.10	C		
Male*16kg	1.02	1.03	CD		
Male*19kg	4.31	0.57	CD		
Female*16kg	4.92	1.17	CD		
Female*19kg	2.57	1.46	CD		
Male*22kg	4.96	0.37	DE		
Male*25kg	6.88	1.53	EF		
Male*28kg	3.45	0.49	EF		
Female*22kg	3.73	1.37	F		
Female*25kg	5.52	0.98	G		

Table 4. Results of interaction effects in ANOVA (Continued)

Interaction	Mean	SD	Subset	*F*-value	Prob. > F
Male*31kg	6.62	1.49	HI	52.28	<.0001*
Female*28kg	7.89	1.47	I		
Female*31kg	9.79	0.37	J		

Signification at a level: *0.0001

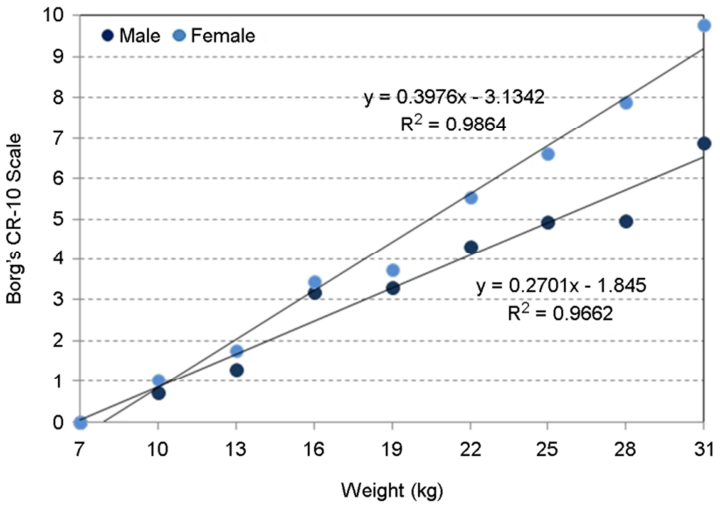


Figure 3. Relationship between physical work load awareness and weight

3.2 NLE (NIOSH lifting equation)

The horizontal position of hands upon applying NLE was measured as 28~61cm, according to the subjects and carrying work, and the vertical position was 73cm, the worktable height from the floor. When carrying the livestock feed in bags was intermittently conducted within ten times per day was assumed, the number of lifting tasks was set within 0.2 times per minute, and the total time of lifting tasks set within an hour. Because, there were no grips on the bags, this study set the coupling coefficient as poor. As a result of NLE evaluation, RWL was revealed as 8.10~11.06. In Table 5, shade was classified on the basis of the LI values within 1.0, between 2.0~3.0 and exceeding 3.0.

As a result of NLE analysis, safe task was shown in that the LI value of both males and females was less than 1.0 in 7kg lifting task. Because LI value was higher than 1.0 but did not exceed 2.0 up to 16kg, it can be regarded as a safe task. In the lifting task of more than 19kg, it was analyzed that lifting task of more than 19kg was dangerous level that can cause musculoskeletal disorders to many workers with the distribution of more than 2.0 of LI value. From the lifting task of more than 22kg, most LI values were distributed as more than 2.0, and it was dangerous level to many subjects (Table 5). As a result of regression model estimation at LI value of 1.7~2.0, which is the point in time of causing lumbar pain, males' was 15.5~18.2kg (r^2=0.99), and females' was 15.5~18.3kg (r^2=0.99). Therefore, both males and females showed almost the same value (Figure 4).

Table 5. Results of NLE evaluation

Gender	Subject	RWA	LI								
			7kg	10kg	13kg	16kg	19kg	22kg	25kg	28kg	31kg
Male	S1	9.65	0.67	1.04	1.35	1.66	1.97	2.28	2.59	2.90	3.21
	S2	9.82	0.71	1.02	1.32	1.63	1.93	2.24	2.55	2.85	3.16
	S3	10.08	0.69	0.99	1.29	1.59	1.89	2.18	2.65	2.96	3.08
	S4	9.45	0.74	1.06	1.38	1.69	2.01	2.33	2.90	2.96	3.28
	S5	8.62	0.81	1.16	1.51	1.86	2.20	2.55	2.92	3.25	3.59
	S6	8.56	0.82	1.17	1.52	1.87	2.22	2.57	3.36	3.27	3.62
	S7	8.10	0.94	1.23	1.61	1.98	2.35	2.72	3.09	3.46	3.83
Female	S8	9.54	0.74	1.06	1.38	1.69	2.01	2.33	2.65	2.96	3.28
	S9	10.43	0.67	0.96	1.25	1.53	1.82	2.11	2.40	2.69	2.79
	S10	8.03	0.87	1.25	1.62	1.99	2.37	2.74	3.11	3.49	3.86
	S11	11.06	0.63	0.90	1.18	1.45	1.72	1.99	2.26	2.53	2.80
	S12	8.40	0.83	1.19	1.55	1.91	2.26	2.62	2.98	3.33	3.69
	S13	8.42	0.83	1.19	1.54	1.90	2.26	2.61	2.97	3.33	3.68
	S14	8.42	0.83	1.19	1.54	1.90	2.26	2.61	2.97	3.33	3.68

*Note: ■ 1.0~2.0, ■ 2.0~3.0, ■ over 3.0

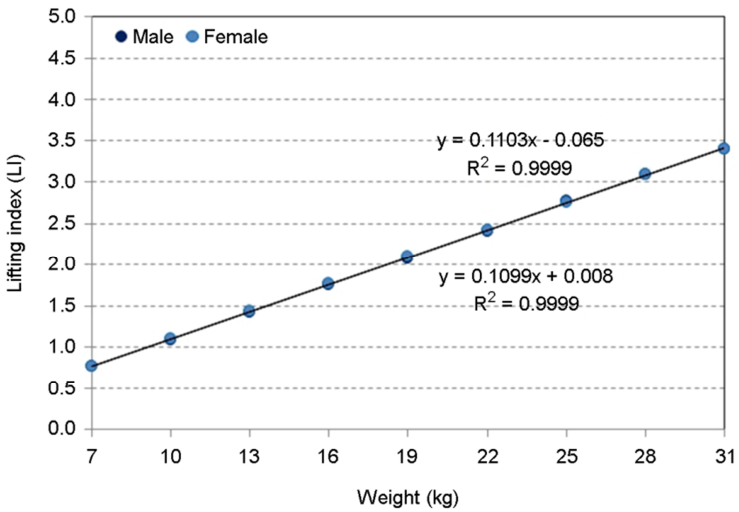


Figure 4. Relationship between LI and weight

3.3 Anthropometric model analysis

The modeling of L5/S1 compressive force evaluation using 3DSSPP was conducted on the basis of start posture (posture before

lifting) and end posture (posture at the final target point) using the anthropometric values per subject measured in the experiment. As a result of the 3DSSPP analysis, the evaluation can be revealed as acceptable, critical and unacceptable, and the values were classified through shade. Table 6 summarizes the values of 3DSSPP L5/S1 compressive force.

Table 6. Results of anthropometry model analysis

Gender	Subject	Weight (kg)	7	10	13	16	19	22	25	28	31
		lb	34.3	49.0	63.7	78.5	93.2	107.9	122.6	137.3	152.0
Male	S1	Start	2606	2898	3682	3483	3775	4067	4358	4650	4942
		End	1641	1821	1995	2165	2329	2487	2640	2788	2932
	S2	Start	2691	2977	3264	3552	3839	4125	4412	4698	4985
		End	1686	1861	2031	2197	2357	2511	2661	2806	2946
	S3	Start	2761	3050	3340	3631	3921	4210	4500	4688	5078
		End	1722	1897	2068	2234	2393	2548	2697	2842	2982
	S4	Start	3291	3603	3914	4228	4540	4852	5163	5475	5787
		End	1979	2156	2328	2494	2653	2806	2954	3095	3231
	S5	Start	2678	2977	3277	3578	3877	4176	4475	4775	5074
		End	1677	1860	2037	2209	2374	2535	2689	2839	2983
	S6	Start	2454	2747	3040	3334	3627	3918	4213	4506	4799
		End	1560	1744	1921	2095	2262	2423	2580	2731	2878
	S7	Start	2472	2591	2874	3150	3443	3727	4010	4294	4577
		End	1483	1663	1839	2010	2175	2335	2491	2641	2787
Female	S8	Start	2326	2447	2954	3270	3585	3899	4213	4528	4842
		End	1556	1774	1988	2200	2406	2609	2808	3003	3195
	S9	Start	2370	2679	2974	3301	3611	3920	4230	4540	4849
		End	1588	1803	2014	2223	2426	2625	2821	3013	3202
	S10	Start	2781	3099	3416	3736	4053	4371	4689	5006	5324
		End	1806	2017	2223	2427	2625	2819	3008	3194	3376
	S11	Start	2791	3117	3444	3772	4098	4424	4751	5077	5403
		End	1813	2030	2242	2451	2654	28.53	3047	3238	3424
	S12	Start	2459	2778	3097	3419	3738	4057	4376	4695	5014
		End	1632	1851	2065	2277	2483	2686	2885	3079	3271
	S13	Start	2310	2623	2936	3251	3563	3876	4189	4502	4815
		End	1533	1751	1964	2176	2382	2585	2783	2979	3171
	S14	Start	2296	2530	2917	3230	3541	3852	4163	4473	4981
		End	1539	1755	1967	2177	2382	2583	2780	2974	3164

*Note: ■ Acceptable, ■ Critical, and ■ Unacceptable

According to the 3DSSPP result, stable work was possible at less than 13kg for males, and at less than 10kg for females. Although, analysis results may have differences, according to subject's anthropometric characteristics and gender, males were acceptable at 19kg level and females were acceptable at 16kg level.

In the result of this study, no case exceeding 6400N, maximum allowed limit, was shown, according to L5/S1 compressive force values in NIOSH. However, the cases exceeding 4500N in lifting tasks showed 13.5%, and 3400N, the action limit of biomechanical standard, was 28.2%. As a result of L5/S1 compressive force, based on 3400N, males and females showed 14.14 kg ($r^2=0.99$) and 15.81kg ($r^2=0.99$), respectively. According to the estimation of 3DSSPP L5/S1 compressive force weight, based on the values (males: 3529~3790N, females: 3355~3646N) estimated from NLE LI value of 1.7~2.0 (Wang et al., 1998) at the lumbar pain increase point in time, males and females were evaluated as 15.5~18.2kg and 15.4~18.1kg, respectively. This implies that both males and females showed almost the same level of weight. Figure 5 shows the relationship between L5/S1 compressive force and weight.

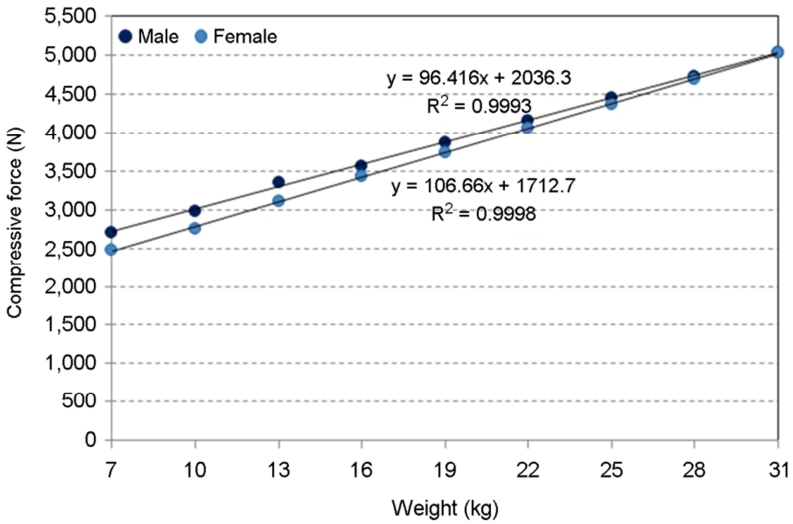


Figure 5. Relationship between compressive force and weight

3.4 Discussion

This study analyzed differences between males and females by measuring physical work load awareness on aged farmers' handling livestock feed in bags (Borg's CR10 Scale), evaluating proper weight through NLE LI evaluation and forecasting L5/S1 compressive force using 3DPPSS. Regarding physical work load awareness measurement, it was 18kg for males and 15.3kg for females. As a result of LI evaluation, males and females were analyzed to be 15.5~18.2kg and 15.5~18.3kg, respectively (almost the same). In the L5/S1 compressive force, males and females were forecast to be 15.5~18.2kg and 15.4~18.1kg, respectively. Although, slight difference is shown according to evaluation method, there is a possibility of causing lumbar pain (LBP) commonly, if the weight exceeds 19kg. Therefore, a caution is judged to be needed. Such a result is compared with the one off task (males: 25kg and females: 15kg) presented by the recommended standard of weight carried by workers aged 50 or older (KOSHA GUIDE G-76-2011). In the case of males aged 60 or older, physical work load appears to be high. The result implies that the 25~30kg of livestock feed bag generally distributed in the livestock farms can cause physical task burden, musculoskeletal disorders and safety accidents to aged farmers. In this regard, improvement on livestock feed in bags taking into account aged farmers' physical

characteristics is considered to be necessary. Although, the domestic recommended standard to carry heavy load by a person is presented for workers up to 51 years old or older, and the limit weight is presented as 12kg for males and 8kg for females in handling manually materials by farmers in their 70s (RDA, 2006). However, the standard has never been applied to farms in reality. In reality that accident rate of aged farmers is 2.5 times higher than that of the farmers in their 30s with the increase of aged farmers, the recommended standard of allowed manual materials handling for farmers aged 60 or older needs to be devised (KOSTAT, 2013).

To review the suitability of the application methods applied in this study, the relationship between physical work load awareness (Borg's CR 10 scale) and L5/S1 compressive force values and NLE LI was additionally analyzed. As a result of correlation analysis, they showed very high correlations with more than 0.99 of correlation coefficient (p-value<0.01). If NLE LI is 1.7~2.0, which is assumed to be the lumbar pain starting point in time, physical work load awareness is forecast to be 2.7~3.6 (r^2=0.98), and L5/S1 compressive forces (r^2=0.99) is predicted to be 3441~3718.6N. When the correlation with L5/S1 compressive force is estimated, If physical work load awareness is 3, it is 3547.9N, and almost matched 3500N, the action limit point in time (r^2=0.99). Such a result almost matches 3400N, the action limit point in time of NIOSH (1991), and NLE LI value of 1.7~2.0 of Wang et al. (1998), and Scale 3 (moderate) of Borg (1993). Consequently, the reliable result is judged to be shown in this study. Figure 6 shows relationship between each evaluation method applied in this study.

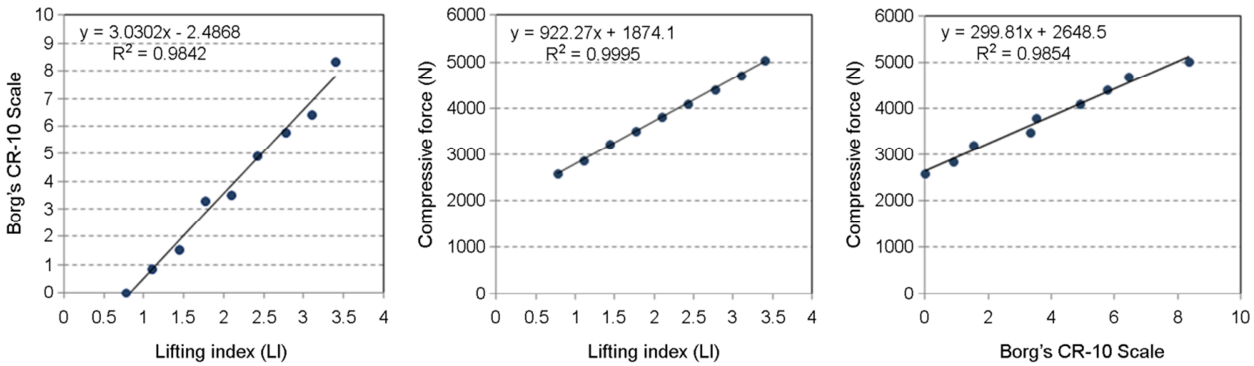


Figure 6. Relationship between physical work load awareness and LI, L5/S1 compressive force

4. Conclusion

This study analyzed using ergonomic techniques to evaluate the proper weight level for aged farmers' handling work of livestock feed in bags. As a result of psychophysical evaluation, physical work load inconvenience rapidly increased from 19kg for females. According to psychophysical regression model estimation result, it was identified that 18.0kg for males and 15.3kg for females were proper weight levels. As a result of anthropometric model and observation model evaluation, proper weight range was 15~18kg, which showed a matching result with the psychophysical measurement result to some degree. From the results above, it seems to be desirable to present recommended weight of a livestock feed bag as 18~19kg for elderly farmers aged 60 or older. In the case of over 19kg, ergonomic improvement including the technological improvement of facilities or convenience device offering is expected to be helpful to the prevention of musculoskeletal disorders and safety accidents. Although, weight by gender was confirmed, when it comes to physical work load awareness in this study, there was limit in identifying differences by gender using NLE LI and 3DPPSS. The reason was that the NLE LI and 3DPPSS evaluated by anthropometry are conjectured to be affected by subject's characteristics. In this regard, a further study on differences according to gender in consideration of Korean standard

anthropometric data needs to be conducted.

The study results above are able to be used as basic data to set standard for livestock feed in bags and institutional improvement for aged livestock breeding farmers in the future.

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