Kastamonu Uni., Orman Fakültesi Dergisi, 2023, 23(1): 22-30 Research Article
Kastamonu Univ., Journal of Forestry Faculty
Doi:10.17475/kastorman.1269480

The Effect of Accessories Used in Interior Furniture on Increasing Safety and Prevention of Overturn

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Received Date: 15.07.2022 Accepted Date: 07.10.2022

Aim of study: Furniture used indoors; threatens the life safety of users by being knocked over for many reasons such as design, production, user errors, earthquakes, etc. This study was carried out to determine the effects of the variables related to the foots used in the furniture and the horizontal forces on the overturning of furniture.

Area of study: This study was carried out in Safranbolu Şefik Yılmaz Dizdar Vocational School Interior Design Department test laboratory.

Material and methods: For the experiments, a leg model, which is widely used in the market, was determined and a multi-purpose cabinet was prepared. Loads were applied to this cabinet with the mechanism established within the scope of TS 9215 and TS EN 14073-2 standards. The effects of the obtained results on overturning were evaluated by analysis of variance and Duncan multiple comparison test.

*Main results***:** It has been observed that the variables such as the position, diameter, height of the foot used in the furniture and the height of the force causing the overturning are effective at various rates in the safe use of the furniture. It has been calculated that the effect of force application heights on overturning is 50.82% at most and foot positions 12.4% at most.

Highlights: The results obtained can be used to increase indoors safety by making it more difficult for overturning of the furniture.

Keywords: Interior, Furniture Safety, Furniture, Furniture Leg, Overturning

İç Mekan Mobilyalarında Kullanılan Aksesuarların Güvenliğin Arttırılmasına ve Devrilmenin Önlenmesine Etkisi

Çalışmanın amacı: İç mekanlarda kullanılan mobilyalar; tasarım, üretim, kullanıcı hataları, depremler vb. birçok sebepten dolayı devrilerek kullanıcıların can güvenliğini tehdit etmektedir. Bu çalışma, mobilyalarda kullanılan ayaklar ile ilgili değişkenlerin ve devrilmeye neden olan yatay kuvvetlerin, mobilya devrilmesi üzerindeki etkilerini belirlemek için yapılmıştır.

Çalışma alanı: Bu çalışma Safranbolu Şefik Yılmaz Dizdar Meslek Yüksekokulu İç Mekân Tasarımı Bölümü test laboratuvarında gerçekleştirilmiştir.

Materyal ve yöntem: Deneyler için piyasada yaygın olarak kullanılan bir ayak modeli belirlenmiş ve çok amaçlı bir dolap hazırlanmıştır. Hazırlanan bu dolaba TS 9215 ve TS EN 14073-2 standartları kapsamında kurulan düzenek ile yükler uygulanmıştır. Elde edilen sonuçların devrilmeye etkileri varyans analizi ve Duncan çoklu karşılaştırma testi ile değerlendirilmiştir.

Temel sonuçlar: Mobilyaların devrilmeden güvenli bir şekilde kullanılmasında, mobilyalarda kullanılan ayakların; konum, çap, boy gibi değişkenlerinin ve devrilmeye neden olan kuvvetin yüksekliğinin, devrilmede çeşitli oranlarda etkili olduğu görülmüştür. Kuvvet uygulama yüksekliklerinin devrilmeye etkisinin en fazla %50.82 oranında, ayak konumlarının ise en fazla %12.4 oranında etkili olduğu hesaplanmıştır.

Araştırma vurguları: Elde edilen sonuçlar, mobilyaların devrilmesinin zorlaştırılarak iç mekanlarda güvenliğin arttırılmasını sağlamak için kullanılabilir.

Anahtar Kelimeler: İç Mekan, Mobilya Güvenliği, Mobilya, Mobilya Ayağı, Devrilme

Introduction

People have used and continue to use different furniture for years to make their living spaces useful and functional. Furniture is an integral part of people's living spaces. People spend most of their lives with furniture.

In addition, to increase the comfort and quality of life in the places where they are used, furniture contains serious security risks due to design, production methods, user-induced errors, negligence, and misuse. Overturning of furniture as a result of effects such as unconscious use, earthquake and light jolts carries vital risks, especially accidents that cause death and injury. Especially in children's living spaces such as children's rooms, pre-school education institutions, dormitories, nurseries, etc., furniture that overturns as a result of unconscious movements of children causes death and serious injuries (Karbakhsh et al., 2008; Sato et al., 2006).

A study was conducted on 8506 patients younger than 17 years of age who were admitted to the hospital due to injury caused by the overturning of furniture between 1990 and 2007 in the USA. In this study, it was found that 90.4% of the injuries occurred in the home environment. Hence, overturning furniture and household equipment is among the most common causes of injury (Gottesman et al., 2009).

School furniture needs to be developed for students beyond architectural adaptations in determining the requirements for the use and development of their furniture. In addition to features such as comfort, easy assembly, adjustment, and use safety factors should be emphasized and importance should be given to the development of these furniture (Tanure & Okimoto, 2018).

Furniture overturning is caused by factors such as tremors and earthquakes, apart from design and user effects. There have been many earthquakes in Turkey in the past, in different provinces and times. Most of the deaths and injuries in earthquakes are caused by non-structural causes. An example of this situation is that household items fall on people or block escape routes (Demiraslan, 2005). In addition, it is seen that most users of furniture do not take precautions such as correct placement and fixing the furniture in the house (Uzun et al., 2015).

Even if the buildings are not demolished in small tremors, most people are harmed as a result of the overturning of the furniture in the place and the panic that arises. In the Kocaeli and Düzce earthquakes that occurred in 1999, injuries occurred as a result of the objects in the place falling over, even in people who came out of the buildings that remained intact (Aytöre, 2005).

The accessories that make up the furniture have an impact on the functionality and safety features of the product. The use of furniture accessories is one of the basic processes of furniture production. The selection and use of accessories according to their appropriate function, model, color, quality, size, and ergonomics affect the quality, appearance, cost, appeal, and sales characteristics of furniture (Kalaycıoğlu et al., 2017). The selection and use of furniture legs, which are one of these components and prevent the furniture from coming into contact with the floor, play an important role in the overturning of the furniture.

The general factors affecting the selection of furniture accessories were determined as brand awareness, affordability, furniture type, quality certificates, furniture trend, supply possibility, warranty period, carrying capacity, delivery time, colour, and integration program. The priority order of these factors varies according to the field of activity and product groups of the enterprise (Kılıç, 2021).

Furniture manufacturers prefer the use of qualified accessories in furniture designs in order to make a difference in a competitive environment and to respond to customer demands (Tatlısu, 2014). Application of concurrent engineering methods in the accessory design and including suppliers in product development processes will increase the quality of accessories (Langner & Seidel, 2009; Jayaram, 2005). The understanding of quality in products can be possible through the bond and information exchange established with suppliers from the beginning of the product development processes (Chung & Kim, 2003).

While choosing furniture components, the expectations of manufacturers from accessories are as follows: Lifetime and warranty period is 44.7%, Authenticity and image is 39.8%, Price is 38.8%, Functionality is 36.9%, Aesthetics features is 32% (Kılıç, 2021).

It is seen that the furniture safety and the effects of the accessories on overturning do not gain the necessary importance and priority in the accessory preferences of the manufacturers. The scarcity of academic studies containing scientific data in the literature on the effect of furniture accessories on safety draws attention (Kalaycıoğlu et al., 2017).

There are many factors such as design, production, preferred accessories and end-users in the safe use of furniture and not toppling over.

In this study, the overturning of furniture, which is one of the most important safety problems encountered in the use of furniture, is examined in the example of a widely used multi-purpose cupboard. The effects of the leg length, leg diameter, mounting places of the leg on the furniture and the force applying height causing the furniture to overturn were investigated. In this way, the risky features of indoor equipment in living areas will be reduced and a contribution will be made to making the environment safer.

Material-Method

Furniture Material

For the experiment, 18 mm and 8 mm thick melamine coated particle board belonging to Kastamonu integrated plant, which is widely preferred in the market and produced in accordance with TS EN 14322 standard, was used in the production of indoor furniture.

Furniture Accessories

Cylinder chrome legs, which are widely used in the market, are used in the selection of furniture accessories. Leg height measurements 6-8-10-12 cm and leg diameter measurements 4.5-5.5-6.5 cm. Leg shoes are made of adjustable plastic.

Preparation of Experimental Samples

The dimensions of the cupboard sample prepared for the experiment are 40 cm x 80 cm x 180 cm (depth, width, height). Cupboard net dimensions are given in Figure 1. 8 mm melamine coated particle board is used as backrest, minifix as fastener and shelf pin for mobile shelves. The cupboard weight is measured as 47.5 kg.

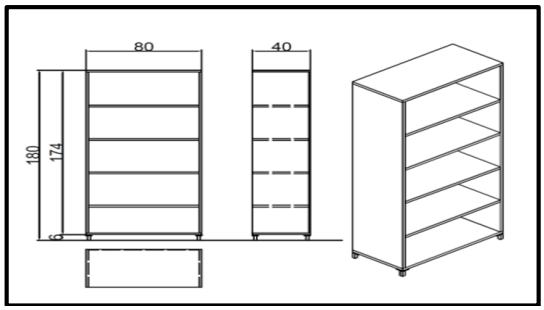

Figure 1. Cupboard net dimensions (cm)

The legs are placed in such a way that they are equal in width and depth, taking the corner points of the cupboard base plate as a reference. Three different studies were carried out on leg placement and four legs were placed at a distance of 3.5 cm, 4.5 cm and 5.5 cm from both sides (Figure 2).

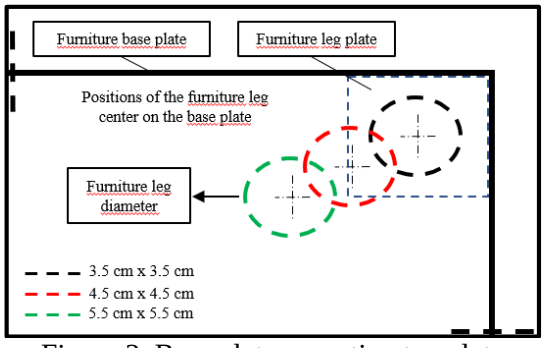

Figure 2. Base plate mounting template

Overturning Test Method

In the study, Safranbolu Şefik Yılmaz Dizdar vocational school interior design education department test laboratory and a universal test device with a load capacity of 5 KN (Kilo Newton) were used. By opening holes at equal intervals on the height-adjustable pulley system, force is applied at different heights in the same direction. Forces are applied in such a way that the frictionless pulley system and the loading pad are in the same direction. The cupboard is placed on a

solid and smooth-surfaced platform which is fixed to the floor. 3 mm high metal stop wedges are mounted on the platform in order to prevent the cupboard from slipping. Moulds were prepared for the assembly of the cupboard legs to the base table and the leg assembly was done precisely. Before each measurement, the balance of the cupboard was checked with a spirit level. The loads placed in the cupboard are placed homogeneously so that they do not support the frame. As a loading pad, wood with a diameter of 100 mm, the front edge rounded with a radius of 12 mm and conforming to the standards was used. The experimental setup is given in Figure 3.

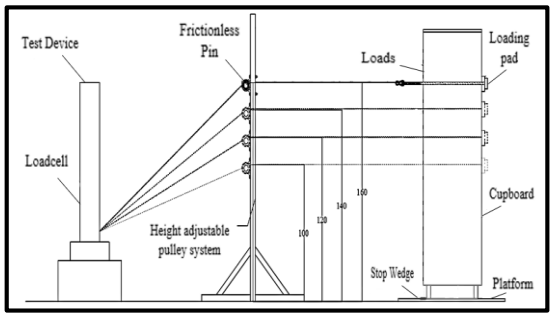

Figure 3. Experimental setup

The tests were carried out by considering the standards of TS 9215 Wood Furniture Strength and Balance Tests and TS EN 14073-2 for the determination of the strength and stability of the office furniture enclosure frame.

For the experiment, the cupboard was loaded in 2 different ways; loaded and unloaded. In accordance with the relevant standard, a homogeneous loading of 1.5 kg and a total of 193.75 kg on 1 dm² for each shelf was made. For the legs used, 4 different lengths of 6 cm, 8 cm, 10 cm, 12 cm and 3 different diameters of 4.5 cm, 5.5 cm, 6.5 cm were applied. In accordance with the TS 9215 standard, a force was applied to the cupboard at 4 different heights, 100 cm, 120 cm, 140 cm, 160 cm. For each variation, 5 repetiti were applied, and a total of 1440 measurements were carried out as 2 loading patterns x 4 leg length x 3 leg diameter x 3 leg positions x 4 force application height x 5 repetitions.

Data Analysis

In this study, the effects of the loaded and unloaded cabinet, the length and diameter of the leg, the position of the leg and the height of the force applied to the cabinet for overturning the cabinets were examined.

In order to determine these data, multiple variance analysis was applied to the results obtained from the study by using the statistical package program. Duncan Test was applied to indicate the degree of importance if the interaction of the factors was significant with a 5% margin of error. The results were evaluated at the 95% confidence interval and the significance level of $p<0.05$.

Results

In the experimental setup, measurements were made on the cupboard, whose unladen weight was 47.5 kg. The average overturning and standard deviation values obtained as a result of the measurements are presented in Table 1.

Table 1. Overturning values of the cupboard (N)

	Unloaded						Loaded					
	Position 1 (3.5 cm x 3.5 cm)		Position 2 (4.5 cm x 4.5 cm)		Position 3 (5.5 cm x 5.5 cm)		Position 1 (3.5 cm x 3.5 cm)		Position 2 (4.5 cm x 4.5 cm)		Position 3 (5.5 cm x 5.5 cm)	
	Average	Sd	Average	Sd	Average	Sd	Average	Sd	Average	Sd	Average	Sd
H1-L1-D1	108.8	0.90	102.66	0.84	96.06	1.02	427.60	1.69	406.94	1.18	370.55	1.16
H1-L1-D2	115.71	0.94	107.01	0.59	100.54	1.01	442.21	2.11	415.41	1.23	395.82	1.28
H1-L1-D3	120.75	2.54	108.39	0.88	102.32	0.99	450.56	3.32	426.64	1.22	407.76	0.99
H1-L2-D1	108.41	1.22	102.29	1.26	95.65	0.61	425.11	1.08	405.04	1.19	375.73	3.22
H1-L2-D2	113.67	0.90	106.61	1.73	98.29	0.95	436.00	1.15	415.22	0.66	394.11	1.03
H1-L2-D3	118.28	0.94	108.03	1.62	101.30	0.87	444.55	1.04	424.95	1.23	404.39	0.87
H1-L3-D1	109.13	0.58	102.91	0.67	92.80	0.77	425.14	0.75	404.20	0.74	370.66	0.84
H1-L3-D2	112.14	0.96	106.38	0.47	98.54	0.99	435.64	0.90	414.15	2.00	384.91	1.16
H1-L3-D3	116.17	0.85	108.57	0.96	102.21	0.95	443.36	1.09	423.97	1.19	403.42	0.77
H1-L4-D1	108.46	0.93	100.09	0.54	91.38	1.28	421.79	1.42	401.38	1.20	363.64	2.71
H1-L4-D2	112.21	1.31	104.29	0.91	96.27	0.71	431.24	0.81	414.78	1.07	392.09	1.85
H1-L4-D3	114.76	0.75	107.66	0.67	99.81	1.02	438.34	0.72	420.53	1.47	401.59	1.31
H2-L1-D1	86.97	0.94	79.78	0.55	75.30	0.72	355.52	0.93	338.67	1.57	322.29	1.70
H2-L1-D2	89.79	1.58	83.50	0.49	77.48	0.52	365.51	3.48	344.33	1.99	330.13	1.65
H2-L1-D3	94.97	1.02	85.71	0.84	79.53	0.77	375.34	4.83	353.47	2.47	337.66	0.76
H2-L2-D1	85.08	0.97	78.58	1.23	72.97	0.84	352.15	2.01	337.81	1.73	325.55	1.35
H2-L2-D2	88.78	0.65	80.95	1.33	76.24	0.70	362.97	1.14	344.99	1.28	329.63	1.25
H2-L2-D3	94.69	0.37	84.25	0.85	78.13	0.78	372.50	1.41	352.01	1.67	335.93	1.65
H2-L3-D1	85.61	0.81	81.78	1.00	74.51	0.60	350.30	1.78	335.40	0.75	319.74	2.01
H2-L3-D2	88.40	0.61	84.33	0.59	78.34	0.72	362.00	1.17	340.75	1.41	327.04	1.00
H2-L3-D3	92.61	1.39	85.83	0.48	81.89	1.46	370.74	2.26	350.52	1.47	335.86	0.91
H2-L4-D1	85.50	0.71	79.50	0.92	72.80	1.60	351.15	0.92	337.68	1.46	313.25	2.92
H2-L4-D2	88.59	1.26	82.41	0.80	77.07	1.27	360.70	2.06	345.01	1.02	328.05	0.83
H2-L4-D3	91.69	1.38	84.56	0.34	80.01	1.42	369.93	2.00	349.59	1.34	338.88	1.08
H3-L1-D1	78.29	0.59	76.14	0.39	70.75	0.39	330.95	1.83	311.86	3.71	295.36	0.84
H3-L1-D2	82.94	0.62	76.38	0.41	73.97	0.97	345.24	3.09	321.20	1.95	298.89	0.88
H3-L1-D3	84.09	0.49	77.58	0.47	75.88	0.79	357.90	1.23	329.55	5.32	309.07	3.04
H3-L2-D1	78.94	0.79	76.07	0.28	70.73	1.00	327.58	1.30	310.19	1.65	290.45	4.66
H3-L2-D2	82.42	1.00	77.01	0.21	73.92	0.83	342.47	2.20	319.42	1.29	299.14	2.59
H3-L2-D3	84.79	0.39	78.05	1.13	76.36	0.45	354.17	2.58	324.13	2.81	307.76	5.50
H3-L3-D1	77.97	0.59	75.77	0.68	70.84	0.64	330.26	2.53	310.49	1.89	285.69	2.86
H3-L3-D2	81.80	0.82	76.87	0.80	74.38	0.86	341.23	3.37	320.14	2.59	299.46	1.85
H3-L3-D3	84.63	0.78	78.15	1.77	75.90	0.75	348.25	1.74	329.22	2.83	311.25	3.19
H3-L4-D1	78.62	0.78	74.31	0.35	70.01	0.78	324.52	2.90	305.88	2.59	284.22	3.98
H3-L4-D2	82.91	0.90	75.83	0.43	72.12	1.05	337.92	2.54	315.15	3.25	294.45	4.62
H3-L4-D3	85.39	0.54	77.92	1.22	73.47	0.72	349.06	2.94	323.05	4.24	303.95	3.19
H4-L1-D1	68.80	0.45	66.29	0.45	63.94	0.79	278.02	0.84	267.67	0.47	247.40	0.86
H4-L1-D2	70.78	0.30	67.77	0.66	64.88	1.13	283.39	0.52	269.96	1.24	259.93	1.27
H4-L1-D3	72.34	0.41	68.27	0.49	65.75	0.23	296.59	2.77	276.65	2.77	268.46	0.84
H4-L2-D1	68.87	0.65	66.68	0.54	64.46	0.46	278.84	1.88	264.30	0.23	258.92	0.97
H4-L2-D2	70.02	0.69	67.02	1.09	65.76	1.12	288.85	0.47	270.21	0.90	260.29	1.47
H4-L2-D3	71.31	0.48	68.54	0.53	66.51	0.57	292.37	0.65	273.79	1.88	262.05	0.86
H4-L3-D1	72.17	0.70	69.95	0.64	65.21	0.66	297.80	2.14	273.99	2.42	256.17	2.21
H4-L3-D2	73.80	0.52	70.70	0.87	68.31	0.56	278.92	1.17	277.33	0.43	259.90	1.00
H4-L3-D3	75.73	0.47	71.82	0.94	69.63	0.36	310.87	1.36	289.75	0.90	269.56	1.30
H4-L4-D1	71.47	0.63	67.85	0.76	64.09	1.38	298.41	1.02	275.43	0.88	254.89	3.67
H4-L4-D2	73.02	0.46	68.98	2.03	65.37	0.64	289.23	2.36	277.28	1.72	255.68	2.79
H4-L4-D3	74.18	0.12	70.67	1.29	67.02	2.65	299.49	2.31	271.97	3.53	258.83	0.95

H1-H2-H3-H4: 100-120-140-160 cm Force applying height, L1-L2-L3-L4: 6-8-10-12 cm Furniture leg length, D1-D2-D3: 4.5- 5.5- 6.5 cm Furniture leg diameter, Position 1-2-3: 3.5 cm x 3.5 cm, 4.5 cm x 4.5 cm, 5.5 cm x 5.5 cm Positions of the furniture leg center on the base plate, Sd: Standard deviation

The result revealed that the lowest average value for the unloaded cases was 63.944 N in 160 cm height, 6 cm leg length, 4.5 cm leg diameter (H4-L1-D1) and 5.5 cm x 5.5 cm leg position, the highest average value was 120.748 N in 100 cm height, 6 cm leg length, 6.5 cm leg diameter (H1-L1-D3) and 3.5 cm x 3.5 cm leg position, and the lowest average value for the loaded cases was 247.402 N in 160 cm height, 6 cm leg length, 4.5 cm leg diameter (H4-L1-D1) and the highest average value was 450.564 N in 100 cm height, 6 cm leg length, 6.5 cm leg diameter (H1-L1-D3) and 3.5 cm x 3.5 cm leg position. Analysis of variance related to the load cases, force application heights, leg lengths, leg diameters, and leg positions was evaluated at the $p<0.05$ level, and their significance levels are presented in Table 2.

Table 2. Multiple variance analysis results (N)

Sources of Variation	Sum of Squares	Degree of Freedom	Average Square value	F	Significance Level
Corrected Model	25469691.235	287	88744.569	34124.244	0.000
Constant Term	63989991.835	1	63989991.835	24605563.320	0.000
A	23281006.827	1	23281006.827	8952060.646	0.000
B	1449009.183	3	483003.061	185725.331	0.000
C	929.928	3	309.976	119.193	0.000
D	31773.954	2	15886.977	6108.893	0.000
E	145085.200	2	72542.600	27894.230	0.000
A * B	481761.096	3	160587.032	61749.256	0.000
A * C	262.729	3	87.576	33.675	0.000
A * D	9473.976	2	4736.988	1821.476	0.000
A * E	47076.637	2	23538.319	9051.003	0.000
B * C	2732.872	9	303.652	116.761	0.000
B * D	3256.532	6	542.755	208.701	0.000
B * E	4788.758	6	798.126	306.897	0.000
C * D	336.454	6	56.076	21.562	0.000
C * E	361.033	6	60.172	23.138	0.000
D * E	694.728	4	173.682	66.785	0.000
A * B * C	830.805	9	92.312	35.496	0.000
A * B * D	1167.831	6	194.639	74.843	0.000
A * B * E	1556.939	6	259.490	99.780	0.000
A * C * D	338.126	6	56.354	21.669	0.000
A * C * E	159.128	6	26.521	10.198	0.000
A * D * E	233.692	4	58.423	22.465	0.000
B * C * D	809.757	18	44.987	17.298	0.000
B * C * E	607.865	18	33.770	12.985	0.000
B * D * E	961.247	12	80.104	30.802	0.000
C * D * E	475.524	12	39.627	15.237	0.000
A * B * C * D	799.239	18	44.402	17.074	0.000
A * B * C * E	402.474	18	22.360	8.598	0.000
A * B * D * E	1008.129	12	84.011	32.304	0.000
A * C * D * E	333.521	12	27.793	10.687	0.000
B * C * D * E	723.735	36	20.104	7.730	0.000
A * B * C * D * E	733.315	36	20.370	7.833	0.000

A: Load, B: Height, C: Length, D: Diameter, E: Position

According to the analysis of multiple variances results, the loaded and unloaded cupboard, the positions of the legs on the base plate, the height of the force applied, the leg length, and the leg diameter parameters were determined to be significant separately on the overturning actions of the cupboard.

In addition, the results indicate that the double, triple, quartet, and quintuple variations were also significant among themselves. Duncan Test results regarding the effect of the height of the force applied to the cupboard on the overturning are presented in Table 3.

Table 3. Duncan test results regarding the effect of the height of the force applied to the cupboard on the overturning (N)

Heigh (cm)	Average Value (N)	Homogeneity Group
100	259.14	D
120	214.04	C
140	198.21	B
160	171.82	A

As a result of the statistical comparison of the effect of the force application height on the overturning values, it was seen that there is a statistical difference between all the force application heights. In addition, it was observed that the average overturning value decreased as the force application height increased. Duncan Test results regarding the effect of the height of the leg on overturning are presented in Table 4.

Table 4. Duncan test results regarding the effect of the height of the leg on overturning (N)

Length (cm)	Average value (N)	Homogeneity Group
6	211.59	C
8	210.6	B
10	211.44	C
12	209.57	A

As a result of the statistical comparison of the effect of the leg lengths on the overturning values, a statistical difference was observed between the feet of 8-10-12 cm in height. However, there was no statistical difference between 6 cm and 10 cm in height. It was seen that the average leg height values are very close to each other. Duncan Test results regarding the effect of the leg diameters on tip-over are presented in Table 5.

Table 5. Duncan test results regarding the effect of the leg diameters on overturning (N)

Diameter (cm)	Average Value (N)	Homogeneity Group
4.5	205.01	A
5.5	210.86	B
6.5	216.52	C

As a result of the statistical comparison of the effect of the leg diameter on the overturning values, it was seen that there is a statistical difference between all leg diameters. In addition, it was observed that the average overturning value increased as the leg diameter increased. Duncan Test results regarding the effect of the position of the legs on the base plate on the overturning are presented in Table 6.

Table 6. Duncan test results regarding the effect of the position of the legs on the base plate on the overturning (N)

Position (cm)	Average Value (N)	Homogeneity Group
3.5 x 3.5	223.21	C
4.5 x 4.5	210.54	B
5.5 x 5.5	198.63	A

As a result of the statistical comparison of the effect of the positions of the legs used in the cupboard on the overturning values, there is a statistical difference between all leg positions. The Duncan test results regarding the effect of whether the cupboard is loaded or unloaded on overturning are shown in Table 7.

Table 7. Duncan test results regarding the effect of the loading condition of the cupboard on overturning (N)

Loading Condition (kg)	Avarage Value (N)	Homogeneity Group
Unloaded	83.65	A
Loaded	337.95	B

It is seen that there is difference as a result of the statistical comparison of the effect of the loaded or unloaded cupboard on the average overturning values.

Conclusions

In this study, the effects of various parameters (the length, diameter, the position of the leg, and the height of the force) on the overturning of the loaded/unloaded cupboards were examined in terms of furniture safety. It was observed that the load was an effective parameter in overturning action of the cupboard. It was observed that the average overturning force in the unloaded cupboard increased by 304% in the loaded cupboard. The reason for this situation is that, as a result of the increase in the force acting on the

gravity centre of the object, it becomes difficult to overturning.

The height of the force applied to the cupboard is effective on overturning at all values. The risk of overturning increased as the force application height increased, and overturning was observed at lower force values. In the test results, it was determined that the average overturning force value applied at 100 cm height is decreased by 17% at 120 cm height, 24% at 140 cm height and 34% at 160 cm height. The reason for this situation is that the applied force moves away from the moment point (the junction of the foot and the stop wedge).

It has been observed that the leg diameters used in the cupboards are effective in overturning, and the risk of overturning increases as the leg diameter gets smaller. In the test results, it was determined that the average overturning force value obtained at 6.5 cm foot diameter decreased by 3% at 5.5 cm foot diameter, and this rate decreased by 5% at 4.5 cm diameter. As the foot diameter increases, the gravity centre of the object moves away from the object's moment point and overturning becomes more difficult.

It was observed that the positions of the leg used in the cupboard on the base plate are effective in overturning, and the risk of overturning increases as the position of the legs moves away from the base plate edges and approaches the centre. In the test results, it was determined that the average overturning value at the 3.5 cm x 3.5 cm position decreased by 6% at the 4.5 cm x 4.5 cm position and by 11% at the 5.5 cm x 5.5 cm position. The reason for this situation is that as the legs are positioned towards the inner part of the lower table, the object's gravity centre approaches the moment point, making it easier to overturning.

In the tests, the best results were obtained in both loaded and unloaded conditions at 100 cm force application height, 6 cm leg length, 5.5 cm leg diameter (H1, L1, D3) and 3.5 cm x 3.5 cm base plate leg position.

As a result, it is obvious that in the safe use of furniture, whether the furniture is loaded or unloaded, the height of the force and the leg variables such as position, diameter, height are effective in overturning. While designing the furniture and choosing the accessories the safe use of the furniture should be prioritized before aesthetic concerns. The manufacturer should pay attention to producing a safer product before the factors such as ease of production and reduction of cost. In order to reduce the risk of overturning, the diameters of the legs should be chosen as wide as possible, and the legs should be fixed as far as from the centre of the base plate. Leg systems that prevent overturning or increase the overturning threshold should be developed.

It is noteworthy that there are not enough academic studies on furniture accessories in the literature. In addition to the raw materials and fasteners used in furniture production, complementary accessories such as furniture legs are of great importance for the safe use of furniture. The effects of complementary accessories should be examined in more detail, especially to prevent the overturning of furniture and to create safe living areas.

Acknowledgments

This article is based on the PhD. thesis “Increasing Safety and Preventing Tipping in Indoor Fittings Purposed Product Design And Example Applications” authored by Suleyman OZCAN and advised by Assit. Prof. Dr. Cemal OZCAN. The authors are thanks to the anonymous reviewers for their suggestions and comments that improve the content of this article.

Ethics Committee Approval

N/A

Peer-review

Externally peer-reviewed.

Author Contributions

Conceptualization: S.Ö., C.Ö; Investigation: S.Ö.; Material and Methodology: S.Ö., C.Ö.; Supervision: C.Ö.; Visualization: S.Ö.; Writing-Original Draft: S.Ö., C.Ö.; Writing-review & Editing: S.Ö., C.Ö. Other: Author has read and agreed to the published version of manuscript.

Conflict of Interest

The author has no conflicts of interest to declare.

Funding

The authors declared that this study has received no financial support.

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