The Invisible Danger: Third-hand Smoke and Families' Knowledge Levels

Görünmez Tehlike: Üçüncü El Sigara Dumanı ve Ailelerin Bilgi Düzeyi

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ABSTRACT

Objective: The objective of this study was to idenitfy the knowledge levels of families regarding third-hand smoke (THS), which represents the most significant health risk currently, and to raise awareness of the subject.

Material and Methods: The 'Beliefs About Third-hand Smoke' (BATHS) scale was applied to 1016 caregivers. The BATHS scale and sub-factor scale results were compared in terms of participant-related variables such as smoking behaviors, THS awareness and beliefs, and sociodemographic findings.

Results: Awareness of the term THS was very low (8.7%). Statistically significantly low smoking habits and high BATHS scale scores were determined among participants who owned their own homes, those with higher levels of education and income, and in non-parent relatives ($p<0.001$). Parental THS awareness was lower among mothers. Being a university graduate increased awareness 19 times and owning one's own home 2.6 times. While not smoking at all resulted in a significant increase in BATHS scores, it did not affect THS awareness.

Conclusion: Despite the availability of numerous programs and educational material concerning the harm caused by first- and second-hand smoke, levels of information about TSH, a more important but invisible danger, are unfortunately very low in society and among health professionals. It is therefore essential to increase the requisite sensitivity to the issue and to encourage smoke-free society studies.

Key Words: Awareness, Exposure, Smoke, Tobacco

ÖZ

Amaç: Bu çalışmanın amacı, günümüzde sağlığa yönelik en önemli tehdit olan üçüncü el sigara dumanına (ÜSD) ilişkin ailelerin bilgi düzeylerini tespit etmek ve konuya ilişkin farkındalığı artırmaktı.

Gereç ve Yöntemler: 'Üçüncü El Duman Hakkında İnançlar' (ÜDHİ) ölçeği 1016 bakım verene uygulanmıştır. ÜDHİ ölçeği ve alt faktör ölçeği sonuçları, sigara içme davranışları, ÜSD farkındalığı ve inançları ve sosyodemografik bulgular gibi katılımcılarla ilgili değişkenler açısından karşılaştırılmıştır.

Bulgular: Üçüncü el sigara dumanı terimine ilişkin farkındalık çok düşüktü (%8.7). Kendi evi olanlarda, eğitim ve gelir düzeyi yüksek olanlarda ve ebeveyn olmayan akrabalarda istatistiksel olarak anlamlı düzeyde düşük sigara içme alışkanlıkları ve yüksek ÜDHİ ölçek puanları tespit edilmiştir ($p<0.001$). Ebeveynlerin ÜSD farkındalığı anneler arasında daha düşüktü. Üniversite mezunu olmak farkındalığı 19 kat, kendi evine sahip olmak ise 2.6 kat artırmıştır. Hiç sigara içmemek ÜDHİ puanlarında anlamlı bir artışa neden olurken, ÜSD farkındalığını etkilememiştir.

Sonuç: Birinci ve ikinci el dumanın yol açtığı zararlara ilişkin çok sayıda program ve eğitim materyali bulunmasına rağmen, daha önemli ancak görünmez bir tehlike olan ÜSD hakkında bilgi düzeyleri ne yazık ki toplumda ve sağlık çalışanları arasında çok düşüktür. Bu nedenle konuya ilişkin gerekli duyarlılığın artırılması ve dumansız toplum çalışmalarının teşvik edilmesi elzemdir.

Anahtar Sözcükler: Farkındalık, Maruziyet, Duman, Tütün

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INTRODUCTION

Tobacco smoke exposure (TSE) is a major global health problem. This is particularly important in terms of children, who are more susceptible to toxicity present in environments where tobacco smoking occurs (1). Such exposure leads to numerous health problems, including voice difficulties, upper and lower respiratory tract infections, ear infections, asthma, cardiovascular diseases, and even sudden baby death (2).

It is estimated that 40% of children worldwide are exposed to tobacco in their homes (3). This exposure results not only from second-hand smoke (SHS), the passive intake of tobacco smoke, but also from the effect of third-hand smoke (THS), the waste residues created by such smoke (4). These waste residues consist of various components of tobacco smoke not found in fresh smoke but capable of reacting with toxic substances by adhering to surfaces in the environment.

The toxication caused by the accumulation of tobacco smoke on surfaces is more harmful than the smoke itself and SHS. While exposure to SHS results from the involuntary respiration of smoke, exposure to THS occurs via involuntary respiration, swallowing, or even absorption through the skin (5). The following tobacco-specific nitrosamines were detected: N′-Nitrosonornicotine (NNN), 4-(Methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), and 4-(methylnitrosamino)-4-(3-pyridyl) butanal (NNA) can remain in closed environments for several days or even months after tobacco has been smoked, while SHS is removed through ventilation. Indeed, some components can remain on clothing fibers for up to 19 months (6). While adults can choose whether or not to smoke tobacco, children are particularly vulnerable to THS in their play areas, homes, and cars (7). It is important for parents to be made aware of THS, and to the best of our knowledge, no previous studies have assessed Turkish families' knowledge of and attitudes toward the subject.

MATERIALS and METHODS

The data in this cross-sectional study were collected through face-to-face interviews in a tertiary training hospital between 1 February and 1 May, 2022. The requisite sample size was calculated at 384, with $Z\alpha = 1.96$ for a 95% confidence interval, a predicted acceptable margin of error $d = 0.05$, and a 50% estimated knowledge of THS. The study was approved by the Ethics Committee of Samsun Training and Research Hospital (BAE/2022/1/1-01.03.2022).

Care-giver relatives such as parents or grandparents presenting to the pediatric clinic were included in the study. Participants were informed about the purpose of the research, the duration of the survey, the identities of the researchers, and how the data would be stored by means of a special section at the beginning of the questionnaire. Written consent forms were obtained from the participants before the questionnaire was applied. The questionnaire was developed based on a scan of the relevant literature (8,9). The accuracy and clarity of the questionnaire was first tested on 15 parents. It contained 25 questions involving sociodemographic characteristics and the Beliefs About Third-Hand Smoke (BATHS) scale and was capable of completion in a mean seven minutes.

Sociodemographics

The parents were asked to state their age, sex, education level, income level, whether or not they owned their own home, and the age and sex of their children.

Participants' beliefs concerning THS were investigated using the BATHS scale (Table I). The validity and reliability of the Turkish-language version of the BATHS scale were investigated by Önal et al. (10). The scale assesses the persistence of THS in the environment (Factor 1) and the impact of THS on health (Factor 2). Factor 1 includes items describing THS in the built environment, including the persistence of smoke particles, the accumulation of THS, and the ineffectiveness of THS reduction by means other than refraining from smoking in the home. Factor 2 includes the health impact of THS and the transmission of THS other than through the air (11). Participants were asked whether they strongly disagreed, disagreed, were undecided, agreed, or strongly agreed with statements coded on a scale of 1-5. Following a brief explanation of the term THS, participants were then asked whether they believed that this was deleterious to the health of their children.

Smoking behaviors

Participants were asked for the following details concerning smoking:

- Smoking status: 1) I have never smoked, 2) I smoke, or 3) I used to smoke but quit.
- Rules regarding smoking in the home: 1) Nobody can smoke in the home, 2) smoking is only allowed on the balcony, 3) smoking is allowed in specific locations in the home (such as the living room or in front of windows), and 4) there is no set rule, and smoking is allowed everywhere.
- Children's exposure to smoking in the previous two weeks in the home, outside the home (in a closed environment), and in the car was also investigated.

Statistical analyses

A check of the data revealed that <10% were missing. Rows with missing data were eliminated when performing the data analyses. Data were verified for normality of distribution and equality of variances on IBM Statistical Package for the Social Sciences, version 22.0 (SPSS Inc., Armonk, NY, IBM Corp., USA). Descriptive statistics were calculated for participant demographics. Quantitative variables are presented as mean and standart deviation and qualitative data as frequency and percentage. The Independent Samples T-test/ANOVA (in case

Table I: Comparison of smoking behaviors and sociodemographic findings

Smoking behavior	Smoker*	Quit smoking*	Never smoked*	X^2	p†
Sex					
Female	134 (16.5) [a]	223 (27.4) [b]	456 (56.1) [c]	107.678	0.001
Male	94 (46.3) [a]	67 (33.0) [b]	42 (20.7) [c]		
Caregiver					
Mother	133 (17.1) [a]	209 (26.9) [b]	435 (56.9) [c]	116.823	0.001
Father	91 (48.7) [a]	57 (30.5) [b]	39 (20.9) [c]		
Other	4 (7.7) [a]	24 (46.2) [b]	24 (46.2) [a, b]		
Education status					
Elementary school	73 (26.3) [a]	92 (33.1) [a]	113 (40.6) [b]	30.247	0.001
Middle school	53 (29.3) [a]	33 (18.2) [b]	95 (52.5) [a]		
High school	65 (18.7) [a]	114 (32.9) [b]	168 (48.4) [b]		
University equivalent	37 (17.6) [a]	51 (24.3) [a, b]	122 (58.1) [b]		
Caregiver age group				15.098	0.001
<30 years	71 (24.9) [a]	66 (23.2) [a]	148 (51.9) [a]		
30-50 years	151 (22.6) [a]	196 (29.3) [a]	322 (48.1) [a]		
>50 years	6 (9.7) [a]	28 (45.2) [b]	28 (45.2) [a, b]		
Home-owner					
Yes	85 (15.7) [a]	171 (31.5) [b]	287 (52.9) [b]	31.001	0.001
No	143 (30.2) [a]	119 (25.2) [b]	211 (44.6) [b]		
Income					
Lower than expenditure	108 (29.9) [a]	92 (25.5) [b]	161 (44.6) [b]	19.194	0.001
Equal to expenditure	103 (18.3) [a]	174 (31.0) [b]	285 (50.7) [b]		
Higher than expenditure	17 (18.3) [a]	24 (25.3) [a]	52 (55.9) [a]		
Smoke exposure in the car					
Yes	45 (50.0) [a]	13 (14.4) [b]	32 (35.6) [b]	43.947	0.001
No	183 (19.8) [a]	277 (29.9) [b]	466 (50.3) [b]		
Smoke exposure at home					
Yes	119 (55.6) [a]	34 (15.9) [b]	61 (28.5) [b]	171.371	0.001
No	109 (13.6) [a]	256 (31.9) [b]	498 (49.0) [b]		
Outdoor smoke exposure					
Yes	71 (51.8) [a]	16 (11.7) [b]	50 (36.5) [b]	81.768	0.001
No	157 (17.9) [a]	274 (31.2) [b]	498 (49.0) [b]		

***:** *n(%)* **†:** *Pearson's chi-squared test.* **[a,b,c]:** *Each subscript letter denotes a subset of categories whose column proportions do not differ significantly from each other at the 0.050 level.*

of normal distribution) were applied to evaluate differences between scale scores in terms of participant characteristics. Multivariate analysis was then conducted to explore the factors influencing the BATHS scale and subscales, using the generalized linear model. Independent variables included demographics and variables identified as exhibiting a statistically significant association with BATHS scores at univariate analysis. Odds ratios, adjusted for parent gender, parent age, parental education level, and family income were calculated for each dependent variable. Significance tests were bilateral, and p values <0.05 were regarded as significant for all analyses.

RESULTS

Participant characteristics

One thousand sixteen caregivers were included in the study. Eighty percent of the participants were women, and 76.6% were mothers. Individuals defined as the 'others' group, relatives such as grandfathers and grandmothers, represented 5.1% of the participants. The mean age of the parents was 35.36 ±8.9 years (min 18, max 70), 34.2% were high school graduates, and 20.7% were university graduates. The mean age of the children was 72.54± 54.04 months (min 1, max 210), and 55.6% were girls. In terms of income, 35.5% of parents had income lower than outgoings, while 9.2% had income higher than outgoings. More than half (53.4%) of the participants owned their own homes, and 22.4% were active smokers. Evaluation showed that 21.1% of participants reported that their children had been exposed to cigarette smoke in the home in the previous two weeks, while 13.5% reported exposure to smoke outside the home, and 8.9% in the car. In terms of rules regarding smoking within the home, 32.5% of participants reported that no smoking was permitted anywhere, while 42.5% only allowed smoking on an outside balcony (either opening onto the home or closed off from it). In addition, 48.7% of fathers, 17.1% of mothers, and 7.7% of other relatives were smokers, while 26.9% of mothers, 30.5% of fathers, and 46.2% of other

Table II: Comparison of the differences between the BATHS scale and subscale scores of the participants

Category	n (%)	Total BATHS score ±SD	p	Factor1 persistence average ±SD	p	Factor 2 Health average ±SD	p
Caregiver							
Mother	777 (76.6)	3.78±0.53	<0.001*	3.78±0.57	0.001*	3.78±0.53	0.001*
Father	187 (18.4)	3.85±0.83		3.57±0.85		3.60±0.86	
Other	52 (5)	3.86±0.65		3.82±0.72		3.92±0.68	
Education status							
Elementary school	278 (27.3)	3.54±0.62	<0.001*	3.51±0.66	0.001*	3.58±0.69	0.001*
Middle school	181 (17.7)	3.67±0.74		3.61±0.82		3.74±0.76	
High school	347 (34.1)	3.83±0.67		3.79±0.74		3.89±0.68	
University equivalent	210 (20.6)	4.23±0.56		4.22±0.57		4.24±0.61	
Income							
Lower than expenditure	361 (35.4)	3.53±0.67	<0.001*	3.52±0.68	0.001*	3.55±0.68	0.001*
Equal to expenditure	562 (55.2)	3.93±0.66		3.88±0.75		4.00±0.68	
Higher than expenditure	93 (9.1)	4.12±0.67		4.09±0.70		4.15±0.72	
Smoking status							
Smoker	228 (22.3)	3.50±0.58	<0.001*	3.44±0.86	0.001*	3.58±0.63	0.001*
Quit smoking	290 (28.69)	3.73±0.76		3.72±0.70		3.74±0.68	
Never smoked	498 (48.9)	3.99±0.59		3.95±0.65		4.04±0.63	
Home owner							
Yes	543 (53.2)	3.94±0.66	<0.001*	3.90±0.72	0.001*	3.99±0.68	0.001*
No	473 (46.5)	3.65±0.69		3.61±0.74		3.70±0.73	
Age group							
<30 years	285 (28.2)	3.75±0.69	0.325*	3.70±0.74	0.467*	3.81±0.73	0.487*
30-50 years	669 (65.7)	3.83±0.70		3.80±0.76		3.87±0.72	
>50 years	62 (6.2)	3.82±0.58		3.82±0.59		3.82±0.64	
Smoking rules							
No smoking anywhere	330 (30.2)	4.15±0.58	<0.001*	4.12±0.65	0.001*	4.20±0.59	0.001*
Smoking allowed only on the balcony	432 (39.6)	3.65±0.55		3.62±0.63		3.68±0.60	
Smoking allowed in some areas	227 (20.9)	3.63±0.82		3.57±0.82		3.70±0.87	
Smoking allowed everywhere	26 (2.4)	3.53±1.00		3.50±0.98		3.57±1.05	
Exposure at home							
Yes	214 (21.0)	3.49±0.84	<0.001†	3.43±0.89	0.001†	3.57±0.90	0.001†
No	802 (79.0)	3.89±0.62		3.86±0.68		3.93±0.64	
Outdoor exposure							
Yes	137 (13.5)	3.62±0.87	<0.001†	3.56±0.92	0.001†	3.71±0.94	0.001†
No	879 (86.5)	3.83±0.65		3.80±0.71		3.87±0.67	
Exposure in the car							
Yes	90 (8.9)	3.42±0.86	<0.001†	3.34±0.93	0.001†	3.52±0.92	0.001†
No	926 (91.1)	3.84±0.65		3.81±0.71		3.88±0.69	
Aware of third-hand smoke							
Yes	88 (8.7)	4.36±0.62	<0.001†	4.33±0.73	0.001†	4.40±0.55	0.001†
No	928 (91.3)	3.75±0.67		3.72±0.72		3.80±0.71	

***:** *ANOVA,* **†:** Independent Samples T-Test

relatives had subsequently quit, and 56.9% of mothers, 20.9% of fathers, and 46.2% of other relatives had never smoked. In terms of education, 17.6% of smokers and 58.1% of those who had never smoked were university graduates. Smokers constituted 15.7% of parents who owned their own homes and 30.2% of non-home owners. Finally, 8.7% of participants had heard of THS. A comparison of the participants' demographic data according to smoking status is shown in Table I.

Higher BATHS scale scores were observed among non-parent caregivers (3.86±0.65, p<0.001), and among individuals with a higher level of education (university, 4.23±0.56, p<0.001), whose income exceeded their outgoings (4.12±0.67, p<0.001), and who had never smoked (3.99±0.59, p<0.001). Higher scores were also registered by those who owned their own homes (3.94±0.66, p<0.001), in whose homes nobody was allowed to smoke (4.15±0.58, p<0.001), whose children were not exposed to smoking in the home (3.89±0.62, p<0.001), outside the home (3.83±0.65, p<0.001), or in the car (3.84±0.65, p<0.001), and who had heard of THS (4.36±0.62, p<0.001). No significant age difference was determined in BATHS scale scores. Mean total scale scores were 3.75±0.69 among participants aged under 30, 3.83±0.70 for those aged 30-50, and 3.82±0.58 for those aged over 50 (p=0.325) (Table II).

Table III: Logistic regression analysis of the factors affecting participants' awareness of third-hand smoke

Category	B	SE	OR	95% CI	p
Caregiver					
Mother			1		
Father	1.78	.46	5.91	2.42-14.46	0.001
Other	1.62	.51	5.03	1.84-13.71	0.002
Education status					
Elementary school			1		
Middle school	1.27	.31	3.56	1.95-6.51	0.001
High school	1.90	.63	6.64	1.92-22.96	0.003
University equivalent	2.94	.66	18.84	5.21-68.19	0.001
Income					
Lower than expenditure			1		
Equal to expenditure	.95	.32	2.60	1.40-4.84	0.003
Higher than expenditure	1.46	.55	4.28	1.45-12.63	0.009
Smoking status					
Never smoked			1		
Quit smoking	-0.29	.44	.75	.32-1.79	0.517
Smoker	-0.54	.30	.59	.33-1.05	0.074
Home owner					
No			1		
Yes	-1.01	2.96	2.67	1.38-5.19	0.004

SE: *Standart Error,* ***OR:*** *Odds Ratio,* ***CI:*** *Cofidence Interval*

Awareness of the term third-hand smoke

In the logistic regression model, university graduates were approximately 18 times more aware of the term THS than primary school graduates. Individuals with high income were four times more aware of the term than those with low income, fathers six times more than mothers, and those who own their own homes three times more than home owners (Table III).

At the end of the survey, participants were given information about THS and were asked whether or not it is harmful; 83.8% responded that it is harmful, with 12.2% being undecided, and 3.8% describing it as not harmful.

DISCUSSION

Mortality and morbidity deriving from tobacco use and exposure remain a global threat to child health. Although smoking has decreased steadily among adults aged 18 and over in the last 50 years, the prevalence of smoking in Europe as a whole is still approximately 24%. Although public awareness of the damage to health caused by primary and secondary smoking has increased, awareness of exposure to THS, defined as that part of the smoke remaining in the environment long after the cigarette itself has been extinguished, is still inadequate (12). Studies that commenced in 1991 under the auspices of the world's largest cigarette manufacturer are still being published today. These have shown that even if ventilation is performed after a regular eight-hour smoking period, high concentrations of nicotine, nitrosamines, and carcinogenic substances remain in the air for 12 hours, and on carpets, curtains, clothes, and wallpaper for more than two months (13).

Although one child in five worldwide is reported to be exposed to tobacco smoke, the true figure is thought to be much higher because parents under-report smoking in the home and in their cars (14). Cigarette smoking traditionally began as male behavior and a show of strength. However, manipulation on the part of the powerful tobacco industry also encouraged women to smoke, as a supposed symbol of freedom and gender equality (15). Global smoking rates are still higher among men than women (16). Taking up smoking at a young age is directly correlated with low income, low education levels, and membership of the working class (17). In agreement with the previous literature, the prevalence of smoking in the present study was 21%, with a male/female ratio of 2.81, and exposure to smoking was observed at an approximate level of 21.1%. Higher rates of starting and quitting smoking were determined among non-parent caregivers (grandfathers and grandmothers). We attribute this to increasing age-related health and financial limitations and to regret over having smoked in the past.

Lower socioeconomic status, whether in terms of income or education, has been identified as a risk factor for exposure to cigarette smoke (18). This explains the lower exposure to THS associated with higher income, a higher level of education, and owning one's own home. In the present study, being a university graduate was associated with 19-fold higher awareness of THS, a high-income level with four-fold higher awareness, and home ownership with three-fold greater awareness.

Homes and cars represent the principal closed spaces in which children are exposed to passive smoking. Potential areas of exposure to THS include homes in which residents smoke, apartments and houses previously inhabited by smokers, and cars in which people have smoked (19,20). One in three of the participants in this study reported that smoking was not permitted anywhere in the home, which represents the most favorable situation in terms of exposure to THS. Reported rates of smoking prohibition in the home and car among smokers and non-smokers in previous studies were 55.1% and 64.2%, respectively, in Japan, 45.6% and 61.6% in Spain, and 83.7% and 78.1% in the USA (21-23). Some parents in the present study smoked in some or all parts of the home. A study from Israel reported that 39% of smoker parents smoked on the balcony, 34.1% anywhere in the home, and 26.8% only outdoors (7). Smoking in the home, even on the balcony, impacts on children in terms of both SHS and THS. Parents who smoke on the balcony may think that this is not harmful to their children since these are not present at the time. However, children are still exposed to toxic pollutants that adhere to smokers' skin, hair, and clothing. Some components of THS can remain in clothing fibers for up to 19 months, even if smoking takes place in the open air. THS can thus still be harmful to babies and children if they come into contact with contaminated clothing, such as being picked up by smokers. Smoking when children are not present only prevents exposure to SHS, and does not obviate the harmful effects of THS.

Due to the restricted space involved, smoking in cars has been shown to be potentially 23 times more harmful than smoking in the home (24). Smoking in the car may also be an indirect reflection of heavy smoking at home. A recent survey from Ireland showed that one child in seven was exposed to smoking in cars (25). Consistent with the present study, Dai et al. (26) reported that half of smokers in Japan also smoked in their cars. Rates of smoking in cars in Turkey are generally low. We think that one factor in this is that vehicles in which nobody has smoked are easier to sell and fetch higher prices in the country.

One important finding of this study is the 8.7% level of awareness of the term THS. Awareness increased in proportion to education and income, but was lower in mothers. Higher awareness was also determined among individuals who did not permit smoking in the home, but no significant association was found with smoking. We think that the most important factors in this context are the lack of attention paid to THS on the radio, television and social media, the lack of eye-catching public information broadcasts, and the limited level of knowledge of the subject among research and health professionals.

Child health clinicians affect the beliefs of parents concerning the potential harm that THS can inflict on their children. Parents who are advised to quit smoking or to make their homes or cars smoke-free by a pediatrician are more likely to believe that THS is deleterious to their children's health (27). However, the level of awareness of the term THS among health workers in a study from Spain was only 34.8%, showing that awareness also needs to be raised among clinicians (28).

Fathers who smoke more on a daily basis (compared to mothers) are less likely to believe that THS is harmful to children (27). In the present study, too, parents who smoked were three times less likely to believe that THS is damaging to children. Effective educational messages and counseling for parents concerning THS can help promote no-smoking guidelines and encourage the acceptance of assistance for quitting.

All heath care environments must be entirely smoke-free. Bans on smoking will help protect children and the whole family against exposure to SHS and THS. It is particularly important that medically vulnerable children should be able to visit institutions that are free of all forms of tobacco smoke contamination.

CONCLUSION

Information about THS should be included in health promotion and educational campaigns aimed at reducing smoking. Stricter rules preventing smoking in public and private settings should be imposed in order to protect non-smokers and children against the adverse effects of SHS and THS. In addition, encouraging changes in smoking behaviors will not only protect non-smokers against the deleterious effects of SHS and THS, but will also help smokers avoid the effects of tobacco, and will ultimately result in smoke-free environments.

Limitations

This study involved a large number of participants in order to ensure that sound results could be obtained. However, it was performed with parents visiting our hospital's pediatric clinic. It is therefore limited by its single-center nature, and the findings cannot be generalized to the whole country. In addition, smoking history (active smoking and exposure to cigarettes in the home or car) and their effects on health were based on self-reports. Relying on parental self-reports may lead to bias error.

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