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【연구논문】

Validation of a Floor Noise Annoyance Scale (FNAS) in a Community Sample

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ABSTRACT

Noise transmitted between floors in apartments is a major problem of neighborhood conflicts in Korea. While noise annoyance involves multi-components including emotional distress, perceived disturbances, physiological changes, and coping behaviors, one-item scales have been used to assess the level of noise annoyance. Floor Noise Annoyance Scale (FNAS) is a multi-item self-reported questionnaire developed in Korean language to evaluate neighbor noise annoyance from upper floors in residential buildings. For the practical use of FNAS, a validation study on the scale is needed. This study was aimed to examine validity and reliability of FNAS among apartment residents in Korea. Exploratory factor analysis (EFA) results showed that the FNAS has a single factor structure, and the scale showed good internal consistency and test-retest reliability among Korean apartment residents. The FNAS scores were found to be significantly correlated with noise sensitivity, distress intolerance, neuroticism. This study provides support for the utility of the FNAS and shows that the scale is a reliable and valid tool of assessing upper floor noise annoyance among apartment residents.

Keywords : Apartment noise, Floor Noise Annoyance Scale, Validity, Reliability

* Professor, Kyonggi University. The author thanks Prof. Y. Lim, the developer of FNAS, for allowing me to validate the scale and providing information on the scale.

Ⅰ. Introduction

Noise is undesirable sound from the surrounding environment. Sounds such as music can sometimes be perceived as noise depending on one's psychological state and environmental conditions. Noise transmitted between floors in apartments is a major cause of neighborhood conflicts in Korea where 78.4% of homes are in multistory residential buildings(Statistics-Korea 2019). Noises from upper floors is often transmitted through solid structures such as floors, and thus the building structures are related to noise generation(Han 2017; Yoo and Jeon 2014). According to a survey of 3,040 Koreans living in multi-story residential buildings by Anti-Corruption & Civil Rights Commission, 88% experienced annoyed noises from upper floors and 54% had conflicts with their neighbors due to floor impact noises(Anti-Corruption & Civil Rights Commission 2013). Conflicts between neighbors due to noise transmitted through floors have been steadily increasing and sometimes lead to violent conflict, arson and even murder in Korea.

Neighbor noise generated between apartment units in Korea is attributed to building structures, thicknesses of floor concrete slaps and the traditional Ondol culture(Kim 2012). Korean Ondol culture, where the floor is heated and people live on the floor, may be a factor that causes more floor impact sound than the culture where shoes are worn indoors and carpet is used as the floor finishing material(Seo et al. 2016). The most annoying noises from upper floors are generated by floor impacts such as children jumping and by airborne sound such as televisions or singing(Jeon et al. 2010). Floor impact sound is generated from light weight impact sounds like dragging furniture and

heavy weight impact sounds like children's running footsteps(Han 2017). Sound made by children jumping and by the dropping of small items are the greatest sources of neighbor noise in residential buildings(Park et al. 2017). According to data collected from 2013 to 2014 by the Korea Environment Corporation, 80% of complaints about neighbor noise were due to noise from an upper floor and children jumping and adults' footsteps constituted 73% of noise sources(Cha 2014). Korean government revised the law on floor impact sound in 2014 as an effort to reduce the increasing neighborhood conflicts due to floor noises(Ministry of Land 2015). However, the number of cases complaining of floor noises is steadily increasing up to 2018, according to data from National Noise Information Center(NNIC, Statistics by year http://www.noiseinfo.or.kr/about/stairsreqinfo.jsp?pageNo=1201;searched in 2021.2.12.). This trend supports the notion that floor noise annoyance is affected by personal factors such as noise sensitivity, emotional states, and coping capacity as well as physical factors such as building materials or slab thickness(Park 2016; Park et al. 2019). Indeed, recent studies indicated that slap thickness was not the sole factor predicting annoyance caused by floor impact sound, and noise sensitivity, house ownership, and attitude towards neighbors were associated with the responses to noise(Park et al. 2018; Park et al. 2019).

Noise annoyance is unpleasant evaluation to noise sources, which can cause individuals to become distracted, distress, irritated, frustrated, anxious, or angry. Accumulating evidence indicates sustained environmental noise such as traffic and aircraft noise, by acting as a sustained stressor, can cause health problems including cardiovascular disease(Recio et al. 2016) and result in sleep disturbance(Ristovska et al. 2013) and anxiety(Persson et al. 2007). For

neighbor noise, noise annoyance has negative effects on emotion and health(Maschke et al. 2007). Prior studies showed that noise annoyance due to footsteps from the upper floor induced negative emotions such as anger, dislike, irritation, and pain in Koreans(Park et al. 2018) and annoyance caused by floor impacts has been reported to increase electrodermal activity and respiration rate(Park et al. 2017). People annoyed by floor impact noise exhibited disturbed sleep, rest and concentration and complained of tiredness and headaches(Park et al. 2015; Park et al. 2016; Park 2019).

Noise annoyance is associated with multiple responses including emotional distress, perceived disturbances, physiological changes, and coping behaviors. Fidell et al.(1988) argued that nonacoustic factors are related to noise annoyance and research on this issue is needed. Guski et al.(1999) proposed that noise annoyance involves several components including emotion, experience of disturbance bothering daily activities, attitude, knowledge about noise sound effect, or personal decision. Stallen(1999) viewed noise as stress and proposed a theoretical framework on noise annoyance based on Lazarus' stress model(1966). Lazarus(1966) argued that emotional states induced by stress depend on the individual's cognitive appraisal of stress. Based on Lazarus' theory, Stallen(1999) proposed that noise annoyance is determined by the perceived disturbance, perceived control, and coping capacity for noise. Indeed, previous evidence indicated that annoying noises from the upper floors was associated with perceived disturbance and coping behaviors, such as going outside, making official complaints and considering a home move(Park et al. 2015; Park et al. 2016).

Noise annoyance has been frequently assessed using one-item standardized five or eleven-point scales to assess level of noise

annoyance(Fields et al. 2001). This type of scale enables the amount of annoyance to be measured but is limited in terms of ability to assess various responses associated with noise annoyance, such as emotional, coping, and health-related responses. For this reason, Schreckenber et al.(2018) recently developed the Multi-Item Annoyance Scale(MIAS) to evaluate noise annoyance from transportation including aircraft, railway, and road traffic. This questionnaire comprises of several items involving disturbances to daily activities such as using phone at home, watching TV, and concentrating and perceived coping responses such as closing the windows, feeling at the mercy of the noise, and mentally switching off. Given that floor impact noise is primarily generated by upstairs neighbors and associated with social relational aspect, responses to annoying noise induced by neighbors probably differs from responses to other types of environmental noises such as road, railroad, or aircraft noise. Because the sources of noise are rather specific to persons living on the upper floors, copying responses to floor noise may be related to copying behaviors in social conflict situations. In a study of Bang et al.(2015), about 39% of the participants chose to interact directly with upstairs neighbors who caused noises, 40% requested arbitration or responded legally, and 7% gave up or took retaliatory actions. In consideration of these characteristics of floor noise annoyance, Floor Noise Annoyance Scale(FNAS), a multi-item questionnaire, has been developed to evaluate annoyance caused by noises from upper floor in residential buildings(Wee et al. 2017). This scale is composed of 10 items that evaluate emotional responses, perceived disturbances, and coping responses to annoying noises generated by the upper floors. However, FNAS has not yet been validated, and a validation study is needed for the practical use of the

scale in Korea where floor noise is one of the social problems.

According to the common scale validation procedure(Slavec & Drnovsek 2012), the author took three steps towards validation: dimensionality assessment, validity assessment. and reliability assessment. Dimensionality is defined as the number of common factors required to account for the correlations between items, which can be assessed through exploratory factor analysis(EFA). EFA is usually performed in the early stages of scale development. When performing EFA, researchers assume that their hypotheses on the dimensions of measurement are limited. Validity is the extent to which a scale truly measures what it is expected to measure. Convergent and discriminant validity are key subtypes of validity. Convergent validity refers to the degree to which an instrument is correlated with alternative scales with the same construct. Discriminant validity is the extent to which a scale does not correlate highly with conceptually different constructs. Reliability is the degree to which a scale yields consistent results and is assessed with internal consistency and temporal stability. The most commonly used reliability measures are the Cronbach`s alpha and test-retest reliability.

The current study evaluated the psychometric properties of the developed scale FNAS and its factor structure, convergent/discriminant validity, internal consistency, and test-retest reliability in Koreans living in apartments. FNAS was expected to be unidimensional, in which all 10 items would load on a single factor. Convergent and discriminant validity would be established when similar scales(e.g. noise sensitivity scale) would be more highly correlated than dissimilar scales(e.g. neuroticism scale), and positive correlations would be found between FNAS and other related constructs(neuroticism, distress intolerance,

and noise sensitivity).

Ⅱ. Methods

1. Participants

Two hundred and eighty-two residents of apartments participated in this study. Participants lived in Busan, Daegu, and Gyeongsang-do province in South Korea. Residents were between 19 and 69 years of age(mean age ± SD, 41.30 ± 11.40) and 59.6% were female. Data was collected using the convenient sampling method. The mean hours at home during the day was 11.87(SD=3.16) and mean years elapsed since the completion of building was 13.24(SD=8.35).

These 282 participants were used to analyze the factor structure of FNAS. Among them, 103 participants completed FNAS and other scales and participated in the analysis of convergent/discriminant validity. The other 179 completed FNAS alone. These 103 people were between 25 and 69 years old(mean age ± SD, 42.86 ± 9.21) and 68.9% were women. They spent a mean 11.97 hours(SD = 3.88) at home during the day and for these participants mean years elapsed since the completion of building was 15.05(SD = 8.84).

2. Measurements

1) The Floor Noise Annoyance Scale(FNAS)

FNAS was originally developed by psychologists familiar with noise annoyance in the Korean language through a systematic procedure.

Briefly, 30 items were initially created based on the results of prior studies on floor noises, following recommendation of De Vellis(2003). The contents of items were also based on the most frequently appealed reactions to noise from upstairs neighbors. Ten items were finally selected based on relevance, clarity, and similarity with other items. The items reflect the discomfort experienced by upper floor noise annoyance and evaluate perceived disturbances in daily activities, emotion, coping capacity and behaviors. Some items were included to reflect the unique characteristics of upper floor noise annoyance and its social relational aspects. For example, one item reads, “I want to protest when I can hear noise from the upper floor apartment.” This type of coping response to noise source has rarely been observed for other types of noise, like traffic noise. This item reflects statistical survey data in Korea that upper floor noise victims tend to complain directly to residents living in upper apartments or lodge complaints in management offices. The scale was designed for adults aged 16 and above and to have a single factor structure. FNAS is based on a six-point Likert method ranging from 'strongly disagree'(coded as 1) to 'strongly agree'(coded as 6).

2) The International Personality Item Pool(IPIP)

The International Personality Item Pool(IPIP) was developed by Goldberg(1999) to measure each factor in a five-factor model(i.e., Extroversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience). Participants are required to respond to each of the 50 items using a five-point scale, ranging from 1(very inaccurate) to 5(very accurate). I used the neuroticism factor of the Korean version of the IPIP(Yoo et al. 2004).

3) The Distress Intolerance Index(DII)

The Distress Intolerance Index(DII) was developed by McHugh and Otto(2012) to measure perceived inability to fully experience unpleasant, aversive or uncomfortable emotions. Participants are required to respond to each of the 10 items using a five-point scale, ranging from 0(strongly disagree) to 4(strongly agree). In the present study, the Korean version of the DII was used. The internal consistency of this scale has been reported to be .87(Seo et al. 2014).

4) Weinstein's noise sensitivity scale(WNS)

The Weinstein's noise sensitivity scale(WNS) was developed by Weinstein(1978) to measure attitude toward general noise and emotional response to various environmental sounds encountered in everyday life. Participants are required to respond to each of the 21 items using a six-point scale, ranging from 1(strongly disagree) to 6(strongly agree). In the present study, the Korean version of the WNS was used, which has a reported internal consistency of .87(Oh et al. 2008).

3. Procedure

Permission was obtained from the developer of FNAS(Y. Lim). Participants in the present study completed a battery of self-report questionnaires. It took about 20 minutes to complete the FNAS, the IPIP, the DII, and the WNS. A researcher was available to answer questions.

4. Data analysis

Data were analyzed using SPSS ver. 21. Exploratory factor analysis(EFA) using the Principal Axis Factoring extraction method was used to reveal the factorial structure of FNAS. Several criteria were used to determine the number of factors: (1) Kaiser's(1961) criterion(i.e. if eigenvalues are ≥1) (2) parallel analysis(Horn 1965), and (3) the Scree test(Cattell 1966). Pearson's correlation coefficients(r) were used to assess relationships between FNAS and other scales. Cronbach's alpha and item-total correlation were used to measure the internal consistency of FNAS. According to Nunnally et al.(1994), a scale is acceptable if it has an alpha value of 〉.70 and a corrected item-total correlation of 〉.30.

Ⅲ. Results

1. Preliminary Analysis

Prior to the main analysis, I examined the relationship between the FNAS and gender, age, hours at home, and building age. Previous results showed that noise annoyance correlated with age or gender(Beheshti et al. 2019; Michaud et al. 2005). Also, previous studies on floor noise suggested that hours at home and building age could influence on floor noise annoyance(Park et al. 2013; Paunović et al. 2009). According to t test results, no gender difference in the FNAS scores was observed(t = 1.00, p = .31). Pearson correlation analyses showed that the FNAS

scores were not correlated with age(r = .03, p = .52), hours at home(r = -.07, p = .18), or building age(r = -.02, p = .66).

2. Exploratory Factor Analysis

The analysis of the structure of the scale was carried out using EFA. Both the Kaiser-Meyer-Olkin measure of sampling adequacy(KMO = .934) and Bartlett test of sphericity [2245.896 (df=45), p〈.001] showed the appropriateness for conducting the EFA. Only one factor had an eigenvalue 〉 1.0(6.623). Also, according to parallel analysis results, only one factor should be extracted. Cattell's scree test yielded a unifactorial solution as the best choice. As can be seen in Table 1, the single-factor structure of FNAS-items revealed that all 10 items had a loading of ≥.60, explaining 66.2% of the total variance of the construct.

〈Table 1〉 FNAS-item loadings for the single-factor solution[1)]

Item	Factor loading	Comm-unality
7. Because of the apartment upper floor noise, my mind is not always stable.	.861	.741
9. When I can hear the apartment upper floor noise, I get angry and cannot bear it.	.847	.717
3. I want to protest when I can hear apartment upper floor noise.	.814	.662
8. I hate to be home because of the apartment upper floor noise.	.814	.662
2. Because of apartment upper floor noise, everyday life is greatly disturbed.	.813	.660

1) Each item is originally in Korean but translated by the author in English.

4. My sleep is disturbed by apartment upper floor noise.	.804	.646
6. I am always anxious to hear the apartment upper floor noise again.	.786	.617
10. It is almost impossible for me to withstand apartment upper floor noise.	.763	.582
1. When the apartment upper floor noise is heard, it is very painful.	.728	.529
5. I want to move to an apartment where there is no apartment upper floor noise.	.661	.436
Eigenvalue	6.623	
% Variance	66.23	

3. Convergent/discriminant validity

Because all measures were normally distributed(e.g., for FNAS, skewness = .699 and kurtosis = .258, for IPIP-Neuroticism, skewness = .238 and kurtosis = .509, for the DII, skewness = .195 and kurtosis = -.727, for the WNS, skewness = -.025 and kurtosis = -.108), Pearson's correlation analysis was used to determine the nature of relationships between the FNAS and other variables(the IPIP-Neuroticism, the DII, and the WNS)(Table 2).

Table 2 presents correlations between FNAS scores, and IPIP-Neuroticism, the DII, and the WNS. FNAS total scores were significantly correlated with measures of neuroticism, distress intolerance, and noise sensitivity(range=.19 to .51). Consistent with theoretical expectations, the FNAS was found to be more strongly associated with noise sensitivity(WNS) than the other variables(the IPIP-Neuroticism: Z=4.492, p<.001 and the DII: Z=3.107, p<.01)(Steiger 1980).

〈Table 2〉 Zero-correlations among the study measures(N=103)

	FNAS	IPIP-Neuroticism	DII	WNS
FNAS	-			
IPIP-Neuroticism	.19*	-		
DII	.30**	.58***	-	
WNS	.51***	.10	.15	-

Note. FNAS, The Floor Noise Annoyance Scale; IPIP-Neuroticism, The International Personality Item Pool-Neuroticism; DII, The Distress Intolerance Index; WNS, Weinstein's Noise Sensitivity Scale. *** $p < .001$, ** $p < .01$, * $p < .05$

4. Reliability and item-level analyses

Internal consistency tests showed that the Cronbach's alpha of the FNAS was .941, which is considerably higher the .70 regarded as an acceptable indicator of internal consistency. Item-total correlations ranged from .64 to .83 for FNAS(Table 3). According to the criterion ≥.30(Nunnally et al. 1994), all 10 items were judged acceptable. Test-retest reliability tests performed at 2-week intervals provided a coefficient of .877 for FNAS.

〈Table 3〉 Mean, standard deviation, correlation of each FNAS item with the sum of the other items and internal consistency if the item is deleted

Items	Mean	SD	Corrected item-total correlation	Alpha if item deleted
1.	3.57	1.10	.70	.93
2.	3.03	1.12	.78	.93
3.	3.21	1.21	.79	.93
4.	3.01	1.19	.78	.93
5.	3.54	1.38	.64	.94
6.	2.82	1.23	.75	.93
7.	2.66	1.14	.83	.93
8.	2.45	1.11	.78	.93
9.	2.63	1.15	.81	.93
10.	2.47	1.11	.73	.93

Ⅳ. Discussion

Neighborhood conflicts due to noises from upper floors is one of the major social problems in Korea. It is important to establish a scale to evaluate the level of annoyance caused by floor noise. Existing scales evaluate noise annoyance with a single item or are specific to noise annoyance generated from transportation. Those scales have limitations in reflecting the unique characteristics of annoyance due to noise generated by persons living in the nearby neighborhood of the same buildings. This study was aimed to examine its factorial structure, convergent/discriminant validity, internal consistency, and test-retest reliability of the developed floor annoyance scale, FNAS,

among apartment residents in Korea. In my study, the scale was found to consist of one factor as was intended by the developer, and showed adequate internal consistency and test-retest reliability when applied to Korean apartment residents.

FNAS scores were significantly correlated with neuroticism, distress intolerance, and noise sensitivity, though it was more strongly associated with noise sensitivity than neuroticism or distress intolerance. These results indicate that annoyance experienced by upper floor noise is affected by neuroticism, distress intolerance, and noise sensitivity and that noise sensitivity is the most proximal variable of floor noise annoyance among three of variables. Noise sensitivity is an internal trait that can affect one's emotions and behaviors caused by noise, regardless of the noise intensity(Job 1999). Given the results of strong correlation between noise sensitivity and floor noise annoyance in the present study, floor noise annoyance is expected to affect one's emotion and coping responses to noise regardless of the floor impact level. Because people with high noise sensitivity tend to perceive noise as an uncontrollable stimulus(Hatfield et al. 2002), people with high level of floor noise annoyance are more likely to perceive the floor impact noise from the upper floors as uncontrollable stressor.

FNAS was found to have good psychometric properties. I suggest this valid scale could be used in various mental health settings associated with disturbance due to upper floor noise and by government agencies with responsibility for issues arising from upper floor noise. FNAS, which measures noise annoyance on a basis of multiple responses, allows to measure the perceived discomfort more objectively. Mental health professionals could use FNAS to assess the degree of discomfort

caused by upper floor noise and government agencies could use the scale to identify those suffering from upper floor noise. In addition, by proving data on level of discomfort caused by upper floor noise, FNAS could provide important hints to those developing intervention programs related to upper floor noise problems. Furthermore, compared to other types of environmental noise sources, floor noise annoyance has more social features, which was reflected in some of the items of FNAS. FNAS allows researchers to study whether noise annoyance due to the floor impact sound would be different from noise annoyance of other environmental noises such as road traffic in the perceived disturbances, emotional intensity, and coping behaviors.

This study has several limitations. First, I used only self-reported data to measure upper floor noise annoyance, and it is possible that the relationship between the upper floor noise annoyance and other variables was exaggerated by the common method variance. I propose more objective data be included in future studies. Second, no physical noise measurements were included in the analysis, and the inclusion of such information may lead to different results. Third, the study participants were recruited from specific regions in Korea, and thus, care should be taken when applying these results in general community population. Finally, this study was not performed on persons that had requested something be done to reduce upper floor noise. The biggest problem of upper floor noise in Korea is that it leads to neighbor conflict. I suggest that studies be conducted on those who have requested action be taken to reduce upper floor noise.

This study provides preliminary support for the use of the FNAS and shows that the scale is a reliable and valid tool of assessing upper floor noise annoyance among apartment residents. All items of the FNAS

were loaded on a single factor, and this result supports Stallen's theory(1999), which proposed that perceived disturbance, perceived control, and coping capacity are primary determinants of noise annoyance. This scale has the benefit of providing objective measure of annoyance severity by evaluating the multiple components of noise annoyance components. The FNAS can be used to develop differential intervention strategies to mediate neighborhood conflicts according to the severity of noise annoyance. Additional studies are required to confirm these findings in those who request action be taken to reduce upper floor noise, and further research is needed to investigate the validity of FNAS using physical noise measurements and to examine the effects of upper floor noise annoyance in relation to variables associated with upper floor noise.

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층간소음불편감 척도의 타당화 연구: 경상도 지역 아파트 거주민을 대상으로

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논문요약

아파트와 같은 공동주택이 주요 거주형태 중의 하나인 우리나라에서 층간소음은 이웃간 갈등을 유발하는 심각한 사회적 문제이다. 소음불편감은 정서적 고통, 지각된 불편, 생리적 변화, 대처행동 등을 포함하는 다차원적인 개념으로 알려져 있지만, 지금까지 대개 단일 문항으로 구성된 척도로 평가되어왔다. 층간소음불편감 척도는 층간소음에 대한 불편감을 평가하기 위해 우리나라에서 개발된 척도로, 다양한 장면에서 활용되기 위해서는 타당화 연구가 필요하다. 이에 본 연구는 아파트 거주민 282명을 대상으로 층간소음불편감 척도를 실시해 신뢰도와 타당도를 검증하였다. 탐색적 요인분석 결과, 1요인이 발견되었으며 내적일치도와 검사-재검사 신뢰도 모두 적절한 것으로 나타났다. 층간소음불편감 척도의 총점은 소음민감도와 가장 강한 상관을 보였고, 고통에 대한 인내력 부족과 신경증과도 유의미한 정적 상관을 보였다. 이러한 결과는 층간소음불편감 척도가 아파트 층간소음으로 인한 심리적 불편감을 측정하기에 신뢰롭고 타당한 도구임을 시사한다.

주제어 : 아파트 소음, 층간소음불편감 척도, 타당도, 신뢰도

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