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A Reliable and Valid Home Visit Report for Studies of Asthma in Young Adults

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Abstract Validated instruments are not available to assess the residential characteristics. The aim of this study was to assess the reliability and validity of an interviewer-administered home visit report. The validity of 48 items in the Home Visit Report was examined against: observations made by a researcher, measurements of relative humidity, cat allergen, and ergosterol, a biomarker of fungal exposure and a biochemical test. Test-retest reliability of 10 fixed residential characteristics was assessed comparing the responses obtained in the main study with the pilot study. Kappa, ANOVA and Wilcoxon Rank Sum tests were applied to assess the agreement and $P<0.05$ was considered as statistically significant. Among 44 items examined for the validity against observations, there was a perfect or almost perfect agreement in 21 ($\kappa=0.9$–1) and substantial agreement ($\kappa=0.6$–0.8) in 19. Higher cat allergen levels were observed with cat ownership and cat being allowed indoors. Observed condensation was associated with relative humidity and observed mould was associated with ergosterol levels. The agreement on the type of carpet and the test was substantial ($\kappa=0.6$). Among 10 items examined for reliability, there was a perfect or almost perfect agreement in 9 ($\kappa=0.9$–1) and substantial agreement ($\kappa=0.7$) in one. In conclusion, the Home Visit Report validated in this study provides reliable and valid data.

Key words Validity; Reliability; Indoor; Questionnaire; Asthma; Residential characteristics.

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Introduction

We have been conducting a cohort study, i.e. 'Environmental Risk Factors for Asthma', to investigate the influence of indoor allergen levels on asthma in a group of young adults aged 20 to 44 years. One of the specific objectives of this study was to identify the residential predictors of indoor allergen levels. Residential characteristics are known to modify the growth of house dust mites and indoor fungi (Chan Yeung et al., 1995; Pasenen, 1992; Wickman et al., 1991) both of which are important risk factors for asthma (Delfino et al., 1996; Peat et al., 1996). These associations need to be clarified in order to design effective avoidance measures. The measurement of residential characteristics is a relatively new concept and no validated instruments were available for this purpose. In most studies which have been carried out to assess the associations between indoor environmental risk factors and asthma, information had been obtained by questionnaires and not validated against objective methods; therefore, the validity of those associations has been questioned (Strachan et al., 1990).

Random misclassification of information reduces the efficiency of a study to detect a significant association. Hence, it is important to use reliable and valid instruments in epidemiological studies. Criterion validity is assessed by comparing the instrument against a gold standard. The lack of available measures that could be considered as gold standards is a common problem encountered in assessing validity. In the absence of a gold standard, the measure could be compared against another measure that varies with the measurement of interest, which is the construct validity. Reliability is the ability to reproduce results on re-testing under the same circumstances (Kelsey et al., 1986).

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We administered a 'Home Visit Report', which is an interviewer-administered questionnaire (originally developed by C. Luczynska, personal communication), to collect information on residential characteristics in our cohort study. We decided to use this home visit report that was developed in East Anglia as the language spoken and housing styles are similar between United Kingdom and Australia. However, the validity and the reliability of this instrument have not been reported to our knowledge. Hence, we assessed the validity and the reliability of the home visit report in a sample of the young adult population in Melbourne, Australia.

Methods

The Home Visit Report

The report consisted of 106 items within 52 main questions. The questions were related to the structure of the house, window dressings, bedding and floor coverings, types of heating and ventilation systems, practices of ventilation, routine cleaning habits for bedding and floor coverings, evidence of dampness, mould and pets.

Sample size

A sample size of 25 is adequate to detect an agreement of 0.7 as statistically significant at $P<0.05$ level with 95% power (Dunn, 1992).

Assessment of validity

We selected the items which could be either validated by direct observations or objective measurements that we had already carried out in the study. These comprised 47 items within 44 questions.

Construct validity of 44 items among 47 was assessed by direct observation on a randomly selected sample of 25 (out of 485) participants in our cohort study on environmental risk factors for asthma. One investigator (S.D.) made independent observations, while the questionnaire was administered by another investigator (J.R.) at each participant's home at the same time. The respondent for the questionnaire was the participant of the study.

The construct validity of 7 items among 47 were assessed against objective measurements on all the participants of the cohort study (n=485). The objective measurements used in this analysis were relative humidity, cat allergen (Fel d 1), ergosterol, which is a biomarker of cumulative fungal exposure (Miller et al., 1988) and total dust collected from the bed and bedroom floor. Relative humidity was recorded in the bedroom at the same visit using a digital thermo-hygrometer (Type THG-388 RS Components, China). This instrument was calibrated in the laboratory by wrapping it in a wet towel to obtain a relative humidity of 95%. The thermo-hygrometer was placed 1 metre above the floor level and away from windows, beds, and heat sources. Bedroom floor dust was collected following a standard protocol (Platts-Mills and De Weck, 1989) and the total dust collected was weighed. Cat allergen level in the floor dust (Fel d 1) was assayed by an enzyme linked immunosorbent assay (Chapman et al., 1988; Luczynska et al., 1989). Ergosterol in the floor dust was assayed by high-performance liquid chromatography (Martin et al., 1990).

The criterion validity of the question on the type of

Table 1 Kappa values for the 44 items validated against observations

Groups of variables	Kappa
Structure of the house	
Type of house (1)	1.0
Walls of house (2)	0.9
Base structure (2)	0.6, 0.7
Heating systems	
Central heating (2)	0.9, 1.0
Air conditioning (2)	0.9, 1.0
Ventilation	
Extractor fan over the cook-top (2)	0.8, 1.0
Ceiling fan in bedroom	1.0
Extractor fan in bathroom	1.0
Opening window in bathroom	0.8
Open bedroom windows at the time of visit	0.6
Floor coverings	
Fitted carpets in bedroom	1.0
Floor rugs in bedroom	1.0
Carpets in bathroom	1.0
Windows	
Double glazing	1.0
Types of window dressings (6)	0.6–1.0
Bed	
Number and the size of beds (2)	1.0
Type of bed	0.8
Allergen covers	1.0
Doona on bed and the type of filling (2)	0.8, 0.9
Blankets on bed	0.9
Pets	
Cat ownership	0.4
Cat allowed inside the house	0.05
Dog ownership	0.7
Dog allowed inside the house	0.05
Any other furry pets inside the house	1.0
Vacuum cleaner – ownership and type (2)	0.8, 1.0
Having a gas oven or cook-top	1.0
Visible dampness in bedroom and adjoining room (2)	0.8
Observed condensation on the bed room window	0.03
Visible mould	0.8

Numbers within parentheses indicate the number of items examined for the given variable if there was more than one item

bedroom carpet was assessed against a biochemical test of a carpet sample (n=25) (personal communication, S. Brown, CSIRO, Melbourne, Australia). The solubility of fibres in sodium hypochlorite was used to differentiate between pure wool and synthetic fibre carpets. A small piece was taken from the bedroom carpet with the permission of the resident and a few fibres were added to 5 ml of sodium hypochlorite (40 g/l). Carpet was identified as a pure wool carpet if fibres completely dissolved in the solution.

Assessment of reliability

The reliability was assessed by comparing the responses obtained during an initial pilot study with the subsequent responses from the main study. The pilot study was conducted with 160 members of the cohort of the main study in 1995 and the main study was conducted with 485 in 1996. We selected the questions to which the answers would not have changed over a period of one year which comprised 10 fixed residential characteristics related to type, age, construction and heating system of the house. Only participants who were interviewed by the same investigator (J.R.) in both years (n=37) were included in this analysis. Residents who had moved to a new house after the pilot study were excluded from this group.

Analysis

Data were analyzed using the Statistical Analytical System package (SAS, 1988). Kappa was used to assess agreement between the responses of the resident and the observations, according to the guidelines of Landis and Koch (1977). Depending on the distribution of data, Analysis of Variance or Wilcoxon Rank Sum tests were used to examine agreement between objective measurements and the responses of the resident. $P<0.05$ was considered as the level of statistical significance.

Results

Forty-four items were examined for construct validity against direct observations. Table 1 describes the range of kappa values observed for different groups of variables. Twenty-one were found to have almost perfect agreement ($\kappa=0.9$–1.0) and the agreement of 19 items

Table 2 Questions validated against objective measurements

Question	Response	No. n=485[a]	Median/Mean of the indicator	P-value
Cat ownership			Median Fel d 1 (μ/g dust)	
	Yes	155	88.8	<0.001[b]
	No	328	0.8	
Cat allowed indoors			Median Fel d 1 (μ/g dust)	
	Yes	145	105.4	<0.001[b]
	No	10	3.4	
Cat allowed in bedroom			Median Fel d 1 (μ/g dust)	
	Yes	105	135.2	<0.001[b]
	No	40	19.6	
Condensation on windows ever			Mean Relative Humidity	
	Yes	275	61	<0.001[c]
	No	210	58	
Mould in bedroom ever			Mean Ergosterol (μ/g dust)	
	Yes	168	4.3	<0.001[c]
	No	278	2.2	
Vacuuming frequency of the bed			Mean Total Dust (grams)	
	At least 1/month	25	0.30	0.08[c]
	2/year	30	0.31	
	1/year	28	0.33	
	<1/year	402	0.35	
Vacuuming frequency of the floor			Mean Total Dust (grams)	
	>1/week	69	0.43	0.001[c]
	~1/2 weeks	345	0.59	
	~1/month	45	0.66	
	<1/month	25	0.62	

[a] Numbers do not add up to 485 in all questions due to missing information or due to the inclusion of the group relevant to the question
[b] Wilcoxon Rank Sum Test was used to test the statistical significance
[c] ANOVA was used to test the statistical significance

ranged from 0.6–0.8 ($P<0.05$) which is substantial according to published guidelines (Landis and Koch, 1977). Only in 4 items was the agreement between the questionnaire responses and the observer <0.6 and not statistically significant. These items were: condensation on the windows ever, cat ownership and whether cats and dogs were allowed inside the house. The validity of the question on the type of bedroom carpet as assessed by the solubility in sodium hypochlorite, was substantial ($\kappa=0.6$; $P=0.002$).

Among the items related to the structure of the house, base structure had the lowest agreement ($\kappa=0.6$). Cat ownership was found to have less validity ($\kappa=0.4$) than dog ownership ($\kappa=0.7$). The item with the least degree of agreement between the resident's answers and the observer was having ever observed condensation on the bedroom window.

The agreement between responses of the residents and objective measurements were significant, with the exception of frequency of vacuuming the bed (Table 2). Cat allergen levels in the bedroom carpet were significantly higher in houses where the resident admitted cat ownership, allowing the cat inside the house and allowing the cat in the bedroom. Relative humidity was significantly higher in houses in which the resident had ever observed condensation. Cumulative fungal exposure as assessed by ergosterol was significantly higher in houses where the participant had ever observed mould. Total dust obtained from the floor was significantly related to the frequency of vacuuming.

The reliability of 9 questions related to the construction of the house, heating system and mechanical ventilation was almost perfect ($\kappa=0.9$–1; $P<0.05$). The reliability of the question on the type of carpet was substantial ($\kappa=0.7$; $P<0.05$).

Discussion

The validity and reliability of the Home Visit Report was shown to be good. Very few studies have attempted to validate the questionnaire information on residential characteristics against objective measurements. Moderate to substantial agreements had been observed between reported mould and dampness with observed mould and dampness ($k=0.4$–0.7) (Verhoeff et al., 1995). The respondents' perception of home dampness has been shown to correlate with spore concentrations (Wageningen et al., 1987).

Information obtained from direct observation was not considered as a true gold standard for two reasons. Firstly, the observer was not an expert on home design and secondly the characteristics that varied over time were less likely to be detected, e.g., condensation on the window ever, pets being allowed inside, etc. The problem with assessing validity in the absence of a gold standard is that conflicting answers could be due to an inaccuracy in either of the methods of assessment. The interpretation of such disagreements depends on the individual question that is being investigated (Kelsey et al., 1986).

Low agreement for variables like cat ownership and allowing pets inside the house is very likely due to misclassification by the observer as the pets may not have been present at the time of the visit. The same explanation could apply to the poor agreement between observing condensation on the windows in the room and the response of the resident. The high agreement between the resident and objective measurements of such variables support this argument and confirms the validity of these questions. The agreement between observer and the respondent was substantial or more in all the other questions. Similarly, all the questions examined for reliability had an agreement of substantial or more.

In conclusion, any misclassification of the information that is obtained using this questionnaire would be minimal. This is a reasonably valid and reliable instrument that can be used to assess residential characteristics in future epidemiological studies of indoor environmental factors.

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