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The Reliability and Validity of a Structured Interview for the Assessment of Infectious Illness Symptoms

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Respiratory infections are the leading cause of morbidity in community populations. We developed a structured interview based on the Health Review (Rose et al., Psychosom. Med. *40: 142-165, 1978) to provide a simple method for periodic assessment of infectious illness, particularly upper respiratory infections. Congruence between interview data and physician diagnoses demonstrated excellent agreement regarding the presence or absence of an infection. Subjects who showed a clinically significant increase in antibody titers to an influenza virus vaccine reported fewer than half as many respiratory infections in the subsequent year as subjects who did not show a significant response. Interrater and test–retest reliabilities were satisfactory. These data support the reliability and validity of this method of assessing infectious illnesses.*

KEY WORDS: infectious illness; assessment; reliability; validity.

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INTRODUCTION

Respiratory infections are the most common infectious illness and the leading cause of morbidity in community populations worldwide (Pio *et al.*, 1985). Respiratory infections take their heaviest toll on the elderly: mortality from influenza is four times greater among people over 60 than people under 40 (Burns and Goodwin, 1990), and pneumonia and influenza are the fourth leading cause of death among people over 75 (Yoshikawa, 1983).

Laboratory tests are the ideal method for documenting an infectious illness; however, laboratory methods, e.g., detection of specific antibody responses, are costly and labor-intensive (Stone *et al.*, 1994). Physician diagnoses offer another way to provide clinical documentation of an infectious illness but can be difficult to obtain. In addition, although nonseekers of medical attention do not differ from seekers on the number and type of symptoms they experience (Frank *et al.*, 1992), many individuals may not seek medical attention for a variety of reasons, including income and insurance coverage (Maddox and Douglas, 1973).

Self-reports can be used to assess infectious illnesses, but the validity of self-reported health data has been questioned because of their correlation with psychological distress (Mechanic, 1980). The argument against using self-reported health data assumes that psychological distress leads to a spurious overreporting of symptoms. Indeed, when respondents rate such diffuse symptoms as fatigue and headaches, correlations with psychological distress are high; however, self-report methods that focus on very specific, well-operationalized symptoms show more reliable associations with physicians' diagnoses.

For example, Rose *et al.* (1978) developed a checklist to assess illness symptoms in a sample of air traffic controllers who ranged in age from 25 to 49. A computer algorithm was used to make illness diagnoses, and this diagnosis was compared with physician diagnoses in a later study (Jenkins *et al.*, 1980). The algorithm diagnosis exactly matched the physician diagnosis in 49 of the 58 illnesses that the air traffic controllers reported over a 2-month period. Moreover, all diagnostic differences were minor discrepancies within the general category of acute respiratory illness. For example, the algorithm might have diagnosed "cold-like" symptoms as an upper respiratory infection (ICDA 465.0), while the physician might have assigned a common cold diagnosis (ICDA 460.0).

Although the results from the Jenkins *et al.* (1980) study demonstrated that the self-administered symptom checklist could provide valid data when the criterion was physician diagnosis, physician interviews were conducted after the subject had reported a cluster of illness symptoms on the Health Review questionnaire. Thus, physician interviews were based on subjects'

retrospective reports 3 to 7 weeks after the initial illness episode. We are unaware of any studies that have assessed the validity of this or any similar instruments with independent physician diagnoses made at the time of illness. In an earlier report, we presented reliability and validity data collected on a smaller sample (Kiecolt-Glaser *et al.*, 1991); this report describes more extensive work and, most importantly, relates influenza vaccine responses to subsequent illness reports.

The procedures that we used to assess infectious illness differ from Rose *et al.* (1978) in two important ways in addition to those described above. Subjects in the air traffic controller study were mailed questionnaires, while we used interviews to assess illness symptoms. A second difference was the length of the reporting period: illness symptoms were assessed once every 3 months in our study compared to the monthly questionnaires mailed to air traffic controllers.

We were interested in the stability of individuals' illness reports over time as well as the reliability of a modified version of the Health Review when administered by different interviewers. Comparisons of physician diagnoses with algorithm diagnoses based on the interview provided a way to assess construct validity. As an additional validity check, we compared subjects' response to an influenza virus vaccine with their reports of infectious illnesses.

An individual's immunological response to a vaccine provides one independent marker of their response to novel antigens. Adults who show poorer responses to vaccines and other antigenic challenges also experience higher rates of clinical illness (Burns and Goodwin, 1990; Hobson *et al.*, 1972), a phenomenon that has also been reported in vaccine studies with children (Sanders *et al.*, 1993) and men infected with HIV (Ochs *et al.*, 1988). While individuals who manifest a poorer antibody response to influenza virus vaccination have a greater probability of subsequent influenza infection (Hobson *et al.*, 1972), a poorer vaccine response in older adults has also been reliably associated with a broader down-regulation of multiple aspects of immune function (e.g., McElhaney *et al.*, 1990; Phair *et al.*, 1978). Accordingly, we expected that poorer vaccine responses would be associated with reports of more frequent and more severe infectious illness.

METHOD

Subjects

All data were collected as part of a large, longitudinal project assessing the effects of stress on psychological health, physical health, and immune

function in older adults. The total sample consisted of 334 individuals with a mean age of 59.48 (SD = 13.80). Females constituted 72% of the sample, and 93% percent of the subjects were Caucasian. Most were married (74%), and the average family income was between $20,000 and $30,000. Most (93%) of the participants had completed at least a high-school education, and many (41%) had completed college.

Both the reliability and the validity of the Health Review interview were assessed using two strategies. For each of these four analyses, a different group of subjects from the larger sample was used. Participants included in the four reliability and validity analyses did not differ on any demographic variables (i.e., age, sex, race, income, education) from those not included.

Procedure

As part of the larger study, subjects were seen annually for extended assessments. At the time of the annual appointment, each subject had a blood sample drawn and completed a battery of questionnaires and clinical interviews, including the modified version of the Health Review. After each yearly appointment, subjects received follow-up telephone calls at 3-month intervals for the next 9 months. During each call, subjects were asked about the occurrence of specific life events and illness symptoms during the previous 3 months. Illness symptoms were assessed using the modified Health Review interview.

Health Review. The Health Review assesses the presence of specific illness symptoms, the approximate data of illness episodes, and the number of days normal activities were restricted. The Health Review also inquires about physician visits and medication usage. We modified the original 32-item Health Review (Rose *et al.*, 1978) to include only those symptoms which could be indicative of an infectious etiology (see Table I). Excluded symptoms included unusual shortness of breath, unplanned loss of weight, chest pain other than heartburn, discomfort from hemorrhoids, difficulty with sexual function, trouble getting to or staying asleep, excess fatigue, neck pain or stiff neck, lower back pain spreading to leg, other pain anywhere in back, stiffness or swelling or soreness of joints in absence of injury, and aches or pains in muscles or joints other than back. In our modified version of the Health Review, we added questions regarding the presence of swollen lymph glands in the neck and cold sores.

A research assistant reviewed all Health Reviews and scored each illness as either infectious or noninfectious, according to an algorithm based on criteria from the ICD-9. All symptoms were assigned a score of from

1 to 3, based on the probability that they were indicative of an infection (see Table I). Summary scores were computed for each episode by adding the assigned value for every symptom present. Episodes reaching a score of 3 or more were counted as infectious illnesses. Total number of days that normal activities were restricted and physician visits were computed for all illnesses categorized as infectious.

In addition to the broad category of infectious illness, separate totals for urinary tract infections, cold sores, and general upper respiratory infections were computed. For the purposes of this paper, we used the broad category of infectious illnesses for the reliability and physician agreement analyses; illness episodes for the vaccine portion of the study included only upper respiratory infections, for reasons discussed later.

During the Health Review interview, we used a number of methods to ensure the most accurate and complete recall. Research has shown that important personal experiences or public events produce "flashbulb" memories regarding specific circumstances in an individual's life around the time of the event (Bradburn *et al.*, 1987). Thus, major public events (e.g., Christmas, the April 15 income tax deadline, Halloween) that occurred during the previous 3 months served as reminder cues during the interview. Recent life events that a subject reported during the follow-up call were also integrated into the Health Review to establish a better frame of reference for the time period in question.

Table I. Health Review Symptoms and Their Corresponding Algorithm Scores, Interrater Reliabilities, and Test–Retest Reliabilities

Symptoms and follow-up questions	Score	κ value: Test–retest	κ value: Interrater
Temperature of 100 or more or felt feverish, too warm, sweaty, and/or had chills	3	.79	.93
Earache or ear infection	2	1.00	—[a]
Sore throat	2	.70	1.00
Swollen lymph glands in neck	3	1.00	.88
Sneezing, stuffy or runny nose (Allergies?)	2	.92	.97
Wheezing, difficulty breathing (Asthma?)	1	.85	.74
Dry cough (more than occasional) (Smoker?)	2	.92	.93
Coughing up substances other than saliva or thin phlegm	3	.48	.55
Nausea and/or vomiting (Was it something you ate?)	1	.37	1.00
Stomach pain or cramps (Was it something you ate?)	2	.70	.65
Diarrhea (Was it something you ate?)	2	.34	.78
Urinary infection	3	1.00	1.00
Cold sore	3	.79	1.00

[a]Kappa could not be computed because the symptom was never reported.

Subjects were initially reminded of any illness episodes they had reported during their prior interview. These reminders helped to ensure that illnesses occurring close to the end of one reporting period were not reported again during the subsequent interview (Bradburn *et al.*, 1987). After being reminded of their prior data, participants were asked if they had been sick since their last interview. If they reported an illness, they were asked what symptoms were present. The interviewer then inquired about the occurrence of each symptom on the checklist whether or not a subject had reported any illness episodes. In this way, each symptom acted as a cue for the individual, maximizing recall of illness episodes in which the symptom was present.

Several of the checklist symptoms (e.g., sneezing, coughing) may reflect noninfectious conditions as well as underlying infections. Because we were interested only in infectious illnesses, the following questions were asked to determine if symptoms suggested an infectious etiology: Was your dry cough related to smoking? Was your sneezy, stuffy, or runny nose due to allergies? and Was your wheezing and difficulty breathing a result of asthma? Subject who reported episodes of nausea or vomiting, stomach pain or cramps, or diarrhea were asked if these symptoms were related to something they had eaten.

Undergraduate research assistants were trained by a post doctoral fellow and clinical psychology graduate students to administer the Health Review interview. Approximately 6 to 10 students administered the interview each year. Training included watching an instructional videotape, role-playing interviews, and administering the Health Review in the presence of a supervisor. The training process took approximately 4 hr.

Procedures for Assessing Reliability

Both interrater and test–retest reliabilities were calculated on approximately 10% of the total sample, similar to reliability assessments with other interview-based measures (e.g., Grove *et al.*, 1981). All Health Review interviews from participants' annual appointments were audiotaped so that a second rater could independently score the information. The sample on which interrater reliabilities were calculated was randomly selected from the larger sample of subjects. A total of 68 illnesses was reported during their interviews; thus, interrater reliabilities were computed for 68 illness reports.

Test–retest reliabilities were computed for 53 illness episodes. Data for test–retest reliabilities were collected during a 1-month period, with all subjects who received a follow-up call during that particular month

participating in the reliability analyses. Because of the importance of maintaining rapport with subjects in a longitudinal study, we felt it necessary to phrase the test–retest assessment in such a way that subjects did not feel their memory was being tested. The procedure was explained as follows: "We are currently training new students to conduct this interview and need to make sure that they are asking the questions correctly. Would you mind if a student called you back to interview you again?" In fact, our test–retest reliability also reflects interrater reliability because the second call was always made by a second interviewer. The disadvantage to this procedure is that the test–retest reliabilities include additional error due to interviewer differences. Recall periods for test–retest reliability varied from several hours to 1 week, depending on when participants indicated that they would be available for the second phone interview.

Procedures for Assessing Validity

The validity of the Health Review interview was assessed by examining the correspondence between the Health Review and physician diagnoses. Subjects included 39 individuals who had visited a physician within the previous year because of illness symptoms. Physician visits that were not related to an acute illness (e.g., annual physical examinations) were not included. If a subject reported having sought medical attention during the Health Review interview, we requested written permission to contact their physician. Physicians were contacted by mail and asked to indicate the date and diagnosis of the subject's illness and whether they believed the etiology was infectious or noninfectious.

In our second assessment of the measure's validity, we examined the correspondence between influenza virus vaccine response and subsequent illness reports on the Health Review interview. These data were collected during a later phase of the study after the immunological aims of the project had been modified. Although all of the subjects participating in the later phase of the study were part of the initial sample, they were older than the sample described earlier (n = 123; M age = 71.20 years, SD = 8.62 years) because younger subjects had been eliminated from the study. During this phase of the project, in addition to receiving the previously described annual interview and follow-up telephone calls, subjects were inoculated with an influenza virus vaccine and their immune response to the vaccine was examined. Influenza vaccination is particularly important among older samples because of the higher mortality rates from influenza (Burns and Goodwin, 1990).

The vaccine's composition is determined annually by the Centers for Disease Control. Of the three influenza virus serotypes in the trivalent vaccine, only one or two typically change each year; thus, subjects who were vaccinated in prior years may have higher baseline levels of antibody and a lower increase in antibody because of ceiling effects (e.g., Beyer *et al.*, 1989). Therefore, analyses on the vaccine data used only subjects who had not received an influenza virus vaccination in the previous year (n = 36). These subjects did not differ from the remaining 87 subjects on age, sex, race, education, or income.

To examine vaccine response, we assessed baseline antibody titers prior to vaccination and compared them with antibody titers from blood samples drawn 10 to 14 days after vaccination. We followed the standard criterion used in vaccine studies to define a clinically significant increase, i.e., a four-fold increase in antibody titers following vaccination (Beyer *et al.*, 1989; McElhaney *et al.*, 1990; Phair *et al.*, 1978).

Individuals who did not respond to the vaccine would clearly be at greater risk for influenza; however, vaccine response also provides a more global marker of the body's ability to respond to other infectious agents, i.e., a window on response to antigenic challenge. Therefore, we compared vaccine responders and nonresponders on the number of illness, the number of days restricted from activity, and the number of doctor visits during the subsequent year.

RESULTS

Reliability

For both interrater and test–retest reliability, Cohen's (1960) κ was computed to examine agreement on the presence or absence of individual symptoms. After the ICD-9-based algorithm was applied, reliabilities for number of illness episodes, days of restricted activity, and physician visits were calculated using Pearson correlations.

Interrater reliability, calculated for 68 illness episodes, showed an overall κ of .87 for individual symptoms, with a range of .55 to 1.00. It was not possible to calculate a κ for earaches because the symptom was never reported. Only two symptoms, coughing up substances other than saliva or thin phlegm and stomach pain or cramps, had interrater κ's below .70.

Test–retest κ's, computed for 53 illnesses, ranged from .34 to 1.00, with an average of .76. Only three symptoms, coughing up substances other than saliva or thin phlegm, nausea or vomiting, and diarrhea fell below .70. The symptoms with the lowest κ's all require a follow-up probe to determine

if the symptom appeared to have an infectious etiology. If the probes were not included in either the initial or the follow-up interview, the symptom could have been improperly recorded as being infectious, leading to lower rates of agreement. As reported earlier, the test–retest reliabilities also include error variance due to using two different interviewers.

Low base rates may also have negatively affected our κ values. For interrater reliabilities, the two symptoms with the lowest κ values were reported fewer than 5 times in 68 interviews. For the 53 test–retest reliabilities, coughing up substances other than saliva or thin phlegm and nausea and/or vomiting were reported 3 and 4 times, respectively, while diarrhea was reported only 8 times. As discussed by Schmitt and Colligan (1984), low base rates can bias correlations in a downward direction, leading to inappropriate inferences about the absence of relationships. Similarly, low base rates can have a negative influence on κ values.

The symptoms with the lowest κ values have assigned scores of less than 2 and were frequently reported as isolated symptoms. Thus, none of them would have been classified as an infectious illness when the algorithm was applied. Given that we were concerned only with infectious illness episodes, and not the occurrence of isolated symptoms, these symptoms would not have affected our rates of infectious illnesses.

When the algorithm was applied to illness *episodes* (i.e., a collection of symptoms experienced as the result of an illness), as opposed to individual symptoms, there was excellent agreement between the two raters who listened to the same interview, with correlations of .99 for total number of illnesses, days of restricted activity, and associated physician visits. Agreement was also good between subjects' first and second reports for total illnesses ($r = .79$), days of restricted activity ($r = .81$), and physician visits ($r = .84$; all p's $< .001$).

Validity

Of the 77 subjects who reported visiting a physician, only 1 did not provide written consent to contact his physician for his diagnosis. The return rate for the physician questionnaire was 54%. Although the return rate was respectable, it underscores the difficulty in using physician diagnosis as a primary measure of infectious illness. Of the 39 forms returned from physicians, 33 provided an infectious illness diagnosis when subjects had also met our criteria. Our evaluations also concurred with reports from four physicians who did not diagnose an infectious illness based on isolated symptoms. Concurrence between physicians' diagnoses and those based on

the Health Review was assessed using Cohen's (1960) κ. Of the 39 cases, only 2 disagreements were found, resulting in a κ of .77.

In the vaccine study, 20 of the 36 subjects (56%) showed a fourfold increase in antibody titers to the vaccine 10 to 14 days after vaccination, a percentage consistent with rates following influenza virus vaccination in other older populations (Levine *et al.,* 1987). A MANOVA that included number of illness episodes, number of days subjects restricted activities, and physician visits over the subsequent year showed a significant difference between subjects who displayed a significant increase in antibody to vaccine ("responders") and those who did not ("nonresponders") [$F(3,31) = 2.99$, $p < .05$]. Nonresponders reported an average of 1.56 (SD = 1.21) illness episodes, compared to less than half that number in vaccine responders (M = 0.65; SD = 1.13). The number of days ill followed a similar pattern, with nonresponders reporting 6.25 days they were unable to perform their routine activities (SD = 10.50 days), compared to 2.40 days in responders (SD = 6.15 days). Nonresponders reported an average of 0.38 (SD = 0.72) physician visits, compared to 0.05 (SD = 0.22) in responders. There was no main effect of gender on the number of illnesses, number of days restricted, or number of doctor visits ($F < 1$), and there was no gender × group interaction [$F(3,29) = 1.67$]. Responders and nonresponders did not differ in age ($F < 1$), with a mean age of 70.81 (SD = 8.60) for nonresponders and 69.78 (SD = 7.26) for responders.

DISCUSSION

Results of our validity analyses suggest that the modified Health Review can be an effective alternative method for assessing infectious illness, even when several months elapse between reports. In addition to demonstrating good interrater and test–retest reliabilities, the validity of the Health Review was supported by its correspondence with physician diagnoses. In all but two cases, the physician's diagnosis of an infectious illness matched the diagnosis produced by the ICD-9 algorithm.

Nonresponders to the influenza vaccine reported more than twice as many illnesses, days of restricted activity, and physician visits in the subsequent year as vaccine responders. Unlike the prior work by Jenkins *et al.* (1980), we were not interested in differentiating among subtypes of respiratory illnesses. While individuals who manifest a poorer antibody response to influenza virus vaccination have a greater probability of subsequent infection by influenza virus (Hobson *et al.,* 1972), poorer vaccine response has been reliably associated with broader down-regulation of immune function in older adults, children, and HIV-infected men (e.g.,

McElhaney *et al.*, 1990; Ochs *et al.*, 1988; Phair *et al.*, 1978; Sanders *et al.*, 1993). Thus, poor vaccine response suggests increased vulnerability to infectious illness in general. As predicted, individuals who did not show a clinically significant response to vaccine had more illness episodes and more days ill than those who did respond.

With the growth of the field of psychoneuroimmunology (PNI), there has been increased interest in the relationship between stress and infectious illness. Although a number of studies have linked stress to the down-regulation of immune function (Glaser and Kiecolt-Glaser, 1994), only a few studies have linked stress to increases in infectious illness (reviewed by Kiecolt-Glaser and Glader, 1995). The time and expense involved in documenting infectious illnesses have limited the number of studies addressing the connection; nonetheless, increasing evidence suggests that such a link does exists. Studies that exposed human subjects to antigens in the form of vaccines (Glaser *et al.*, 1992; Jabaaij *et al.*, 1993) or deliberately infected subjects with pathogens such as cold viruses (Cohen *et al.*, 1991) have demonstrated that stress modulates the speed and potency of relevant immunological defenses, as well as the occurrence and severity of clinical illness. Animal studies have provided convergent evidence as well (Sheridan *et al.*, 1991; Solomon, 1969).

Research relating stress to physical health outcomes, specifically infectious illness, is very important to the field of PNI and more generally to the field of behavioral medicine. The current study suggests that the periodic assessment of recent illness symptoms using an interview format that employs memory prompts may be an effective method of documenting infectious illness episodes. The Health Review interview is best used to assess illness episodes rather than the occurrence of individual symptoms. This interview, which can be easily administered by trained undergraduate research assistants, can be used to assess the occurrence of infectious illness when more costly methods are prohibitive.

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