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## Confirmatory Factor Analysis and Structural Equation Modeling of Socio-Cultural Constructs among Chamorro and Non-Chamorro Micronesian Betel Nut Chewers

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### Abstract

**Objectives**—Betel nut chewing is embedded within the cultures of South Asia, and Southeast Asia, and the Western Pacific. The determinants of betel nut consumption are complex. Ongoing consumption of betel nut is affected by cultural, social, and drug-specific effects (i.e., dependence). This study's first objective was to assess the psychometric properties (i.e., reliability and validity) of the socio-cultural constructs in a survey developed for betel nut chewers. The study's second objective was to investigate the influence of socio-cultural variables on betel nut chewing behaviors among Chamorro and non-Chamorro Micronesians in Guam.

**Design**—The current study was a secondary analysis of a larger study ( $N = 600$ ;  $n = 375$  chewers and  $n = 225$  former chewers) that examined socio-cultural factors that influence why chewers chew betel nut, along with assessing chewing behaviors, perceptions of risks, probability of changing behaviors, and methods that could be used to reduce use or quit. The socio-cultural constructs of the survey were analyzed using confirmatory factor analysis and structural equation modeling.

**Results**—The socio-cultural factors were a sufficient fit with data and the instrument is reliable and valid, as indicated by various model fit indices ( $\chi^2(13) = 18.49$  with  $p = .14$ , TLI = .99, CFI = 1.00, SRMR = .02, RMSEA = .03 with 90% CIs [.00, .07]). Cronbach's alpha, the sign and magnitude of the factor loadings, the inter-factor correlations, and the large proportion of variance extracted for each factor, all indicate that the instrument is reliable and valid. Additionally, multivariate analyses showed that socio-cultural reasons were important contributing or chewing betel nut. Participants cited chewing because their friends and family members chewed, the

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#### Disclosure Statement

There are no financial benefits or financial interests of any of the authors.

#### Conflicts of Interest

All authors declare that they have no conflict of interest.

behavior is embedded within their culture, and it would be considered rude and disrespectful to not chew.

**Conclusion**—Based on the findings, this study provides important implications pertaining to creating culturally appropriate cessation programs.

### Keywords

Betel Nut; Betel Quid; Chewers and former chewers

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## Introduction

Betel nut chewing has been ranked as the fourth most frequently abused substance (following only nicotine, ethanol, and caffeine) with an estimated 600 million people who chew worldwide; Warnakulasuriya 2002a, 2002b; Warnakulasuriya 2002c). Betel nut chewing is indigenous to South Asia, Southeast Asia,, and the Western Pacific and is embedded within the various cultures of those regions (Chu 2002; Croucher and Islam 2002; Gupta and Warnakulasuriya 2002; Strickland 2002). As people migrate to other geographical regions, they bring the practice with them, which has caused a rise in the prevalence of chewing worldwide (Warnakulasuriya 2002a, 2002b). The preparation and consumption of betel nut also varies according to geographical region (Winstock 2002). A rise in prevalence of betel nut use increases health concerns pertaining to chewing.

The term betel nut developed from using a combination of the Betel nut with the Piper betel leaf (IARC, 2014). The Betel nut is a hard brown kernel that is cut in half and folded into the Piper betel leaf with slaked lime and other ingredients such as tobacco (IARC, 2004; Shah, 2002; Winstock, 2002). The betel quid is commonly placed in the back of the mouth to suck and extract the juices from it, and then expectorated” (Shah, 2002; Winstock, 2002). In the current manuscript, the term betel nut will be used to refer to any preparation of the betel nut (with or without ingredients added (Murphy & Herzog, 2015).

### Public Health Concern

From a public health perspective, the increase in area nut chewing worldwide is important because the practice has been categorized as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC; [IARC] 2004b) and has been associated with various forms of cancer including: oral and oropharyngeal cancer, oral leukoplakia and submucous fibrosis, and cancer of the pharynx and esophagus (Oakley, Demaine, and Warnakulasuriya 2005; Shah et al. 2002; Warnakulasuriya 2002a, 2002b). Chewers have cited many reasons for chewing, including acceleration of the cardiorespiratory system (Chu 2002), feelings of euphoria, and feelings of warmth throughout the body (Chu 2002; Shah et al. 2002; Williams 2002; Winstock 2002). In addition, oral fixation, rituals associated with preparation of the betel nut “quid,” along with a desire to prevent withdrawal symptoms also have been cited (Chu 2002; Shah et al. 2002; Williams 2002; Winstock 2002). To adequately intervene with potentially addictive behaviors, it is critical to gain an in-depth understanding of why the behaviors occur. Social cognitive theory (Bandura 1986) was used as the

theoretical framework in the current study to gain an appreciation of the socio-cultural importance of area nut among chewers.

### **Theoretical framework and Ethnic Perspective**

In social learning theory, Bandura (Bandura 1977; Bandura 1986) hypothesized that not only do humans learn through observation and modeling, but that the three elements of environment, behavior, and cognition, all influence each other to determine the outcomes. From observations, humans react according to what they perceive the anticipated outcomes will be (Bandura 1977). If the outcomes are perceived to be positive, one will be more inclined to engage in a particular behavior (Bandura 1977).

The manner in which people behave, act, and think, are defined and influenced by their cultural beliefs. Cultural practices provide a framework of accepted norms for people to conduct themselves (Williams, 2002). In the current study, cultural practices are hypothesized to be influenced by social, cultural, and cognitive factors. For example, a person may be influenced by relatives and friends who chew, (Croucher and Islam 2002; Shah et al. 2002; Warnakulasuriya 2002a, 2002b) and may be unaware of the negative consequences from of chewing. As a result of these influences, the person may begin to chew betel nut (Murphy & Herzog, 2015).

### **Research Objectives**

The first objective of the current study was to assess the psychometric properties (i.e., reliability and validity) of the socio-cultural constructs in a survey developed for betel nut chewers. The second objective was to investigate the influence of socio-cultural variables on betel nut chewing behaviors among Chamorro and non-Chamorro Micronesians on Guam.

## **Methods**

### **Procedures**

The development of the survey instruments evaluated in the current analysis has been previously described (Murphy & Herzog, 2015). Institutional Review Board approval was granted from both the University of Hawai'i at M noa and the University of Guam prior to beginning the study. The larger study was conducted on Guam using a convenience sample of chewers and former chewers. Bilingual research assistants were local community members who spoke Chamorro and English and administered the surveys. Participants were recruited through advertisements in local papers and in local villages and were approached in- person at community events and worksites. Due to a low response rate for published advertisements recruitment was changed to in-person only (Murphy & Herzog, 2015). Research assistants visited worksites, community fairs, and fiestas, and approached groups of potential participants at a time. By using this technique, people who were ineligible or uninterested did not step forward to volunteer and exact numbers regarding ineligibility and those who declined were not recorded. Research assistants ensured that all elements of surveys were completed by each participant. Research assistants screened participants for eligibility and explained the study procedures to participants who provided written consent

prior to survey completion. Once the surveys were completed, participants received a \$25 gift card as compensation for their time.

## Participants

Inclusion criteria consisted of: 18 years or older and those who self-identified as current betel nut or betel quid chewer or former chewer. Current chewers were defined as those who had been chewing for at least 3 years and at least once per week (Murphy & Herzog, 2015). Former chewers were defined as those who had met the operational definition of a chewer and had quit chewing for a minimum of 6 weeks (Murphy & Herzog, 2015).

## Measures

**Demographic and Controlling Variables**—Demographic information related to sex, age, education level, and ethnicity was collected from all participants. Due to ethnic group size limitations (some ethnic groups were too small in number), we did not examine race or ethnicity as a covariate of chewing behaviors. Information pertaining to chewing behaviors was also examined: “How many years have you chewed betel nut or betel quid?” and “Approximately how old were you when you began chewing betel nut or betel quid?” We hypothesized that socio-cultural factors can significantly predict chewers’ behaviors after controlling for these demographic factors.

**Socio-Cultural Items in Surveys**—Two versions of surveys were developed: one for chewers and one for former chewers (Murphy & Herzog, 2015). The 37-item Survey for Betel Nut Chewers assessed socio-cultural, psychological, and behavioral reasons as to why chewers chew, along with perception of risk, and willingness to reduce or quit chewing. Response scales used multiple choice and a 5-point Likert-type scales. Examples of questions that were related to socio-cultural associations included: “How important is betel nut or betel quid in your culture?”; “How common is chewing betel quid in your culture?”; “People have different opinions about the significance of chewing betel nut or betel quid in various social situations. Please rate how important chewing betel nut or betel quid is to you in each situation (birthdays, fiestas, anniversaries of death, parties, rosaries, working, weddings, meetings, hanging out with friends, home with family, men’s meetings, hot baths)”; “Rate how negatively people would think of you if you decided to give up chewing betel nut or betel quid”; “it was rude not to chew”; “People did not respect me if I didn’t chew? (Murphy & Herzog, 2015).” The total score ranged from 0 to 4 (“not important” to “extremely important”).

The 45-item Survey for Former Betel Nut Chewers also assessed socio-cultural, psychological, and behavioral reasons as to why chewers chewed, along with perception of risk, and methods used to successfully reduce or quit (Murphy & Herzog, 2015). Response scales used multiple choice and a 5-point Likert-type scales. The questions were the same as those for the Survey for Betel Nut Chewers and included additional items. Examples of questions that were related to socio-cultural associations that were unique from the Survey for Betel Nut Chewers included: “Do you feel differently when you go to social gatherings and your friends are chewing betel nut or betel quid, but you are not chewing?”; “Are people

impressed that you quit chewing betel nut or betel quid? (Murphy & Herzog, 2015).” The total score ranged from 0 to 4 (“not important” to “extremely important”).

The current study was a secondary analysis of a larger study ( $N = 600$ ;  $n = 375$  chewers and  $n = 225$  former chewers). A pilot study was used to develop both surveys. Participants volunteered and completed the survey appropriate to their status (chewer or former chewer) and participated in an interview immediately after completing the survey. Interviews questions were open-ended format to allow participants to expand on or clarify answers given. Information gained from interviews were used to supplement information given in surveys. All of the information gathered was used to modify and revise surveys to their final format.

### Data analyses

Confirmatory factor analysis (CFA) and structural equation modeling (SEM) were conducted in Mplus separately to address the two main research objectives involving socio-cultural factors to evaluate: 1) their reliability and validity in the Survey for Betel Nut Chewers and the Survey for Former Betel Nut Chewers and 2) to examine their impact on betel nut chewing behaviors.

As explained previously, the Survey for Betel Nut Chewers and the Survey for Former Betel Nut Chewers were created to assess socio-cultural, psychological, and behavioral reasons as to why chewers and former chewers chew(ed), along with perception of risk, and willingness to reduce or quit (Murphy & Herzog, 2015). The underlying dimensionality has not been investigated yet. The three constructs are evidenced by the three factors in a series of exploratory factor analyses using another group of data. Therefore in the current study we applied CFA to a new dataset to validate the psychometric properties of those constructs. From methodological perspective, it is very appropriate to perform cross-validation analyses (Hastie, Tibshirani, & Friedman, 2009).

As another primary research interest was to investigate the relationships between socio-cultural factors and participants’ chewing behaviors, SEM is more suitable because it can model the effect of latent factors on observed dependent variables such as chewing behaviors. Both statistical methods were implemented in Mplus, in which several model fit indices were generated enabling us to assess whether the theoretical models are supported by the empirical data we collected. For this purpose, Chi-square/ $df$  index of fit, the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR) were used. SEM also allowed us to estimate the strengths of the relationships hypothesized.

### Socio-Cultural Constructs

We examined three socio-cultural constructs directly related to chewing behaviors. The first one was “socio-cultural factor.” Three observed measures were used to capture the socio-cultural construct: “I chew betel nut or betel quid because all of my friends chew,” “I chew betel nut or betel quid because my family members chew,” and “I chew betel nut or betel quid because it is part of my culture.” The second construct focused on the negative socio-cultural consequence caused by not chewing. It was gauged by the following measures: “it is

rude not to chew” and “people will not respect me if I don’t chew.” The third construct focused on internal psychological benefits brought by chewing betel nut. Three measures were used: “I chew betel nut or betel quid because it relaxes me,” “I chew betel nut or betel quid because it gives me energy,” and “I chew betel nut or betel quid because I like the way it makes me feel.” Readers may obtain more information about the survey items in (Murphy & Herzog, 2015).

## Results

In this current study, as shown in Table 1, a total of 375 chewers were included in data analyses. The ethnic composition of chewers included: Chamorro 33.1%, Chuukese 29.1%, Palauan 20.3%, Yapese 6.4%, Carolinian 4.5%, and others 6%. Fifty one percent of the participants were male. The mean age of participants was 35.27 years ( $SD = 20.44$ ). The mean years for chewing was 14.70 ( $SD = 12.66$ ). The average age that participants began chewing was 17.77 years ( $SD = 8.76$ ). Average education level achieved by participants was a high school diploma.

Seventy-four percent of chewers stated that they chewed daily. The average times per day that chewers chewed betel nut ranged from 1 to 30 times per day. The largest percentages included: 10 times a day (17.9%) and 20 times per day (10.9%) which indicate that chewing is consistent throughout the day for those chewers. Less consistent chewing behaviors included: 2 times per day (8.3%); 3 times per day (7.5%); 4 times per day (6.1%); 5 times per day (6.9%); 6 times per day (7.2 %); and 15 times per day (7.2%). Only 4.5% of chewers indicated chewing 30 times per day.

The family structure is extremely important in Chamorro and non-Chamorro Micronesian cultures. Family size tends to increase as children marry because they generally choose to live together in one household or live in many households on the same property. Therefore, family influences are very strong. Chewers (50.9%) indicated that they began chewing because of influences from various family members: parents (56.8%); aunts/uncles (58.9%); brothers and sisters (60%); and other children in the home (19.7%). In addition to influence from family members, chewers (45.9%) indicated that they began chewing because betel nut was readily available in the home.

## Confirmatory Factor Analysis

The first objective of the current study was to assess the psychometric properties (i.e., reliability and validity) of the socio-cultural constructs in the Survey for Betel Nut Chewers. The factor structure of this survey (Murphy & Herzog, 2015) have yet to be evaluated. To fully explore the factor structure of all socio-cultural related items, a series of exploratory factor analysis were conducted using another group of 225 former chewers who quit chewing. The three-factor model was considered sufficiently well fit with the former-chewer data. We then validated the hypothetical three-factor structure using CFA models for the socio-cultural reasons of chewing using the group of current chewers. The CFA model fit the data well, as evidenced by various fit indices:  $\chi^2 (13) = 18.49$  with  $p = .14$ , TLI=.99, CFI=1.00, SRMR=.02, RMSEA = .03 with 90% CIs [.00, .07] and the probability that

RMSEA is smaller than .05 is .76. Figure 1 presented standardized model result in a path diagram.

Reliability analysis was applied to determine the internal consistency of the Survey for Betel Nut Chewers. In addition to the commonly used Cronbach's alpha, two other reliability measures proposed by (Fornell 1981; Hancock 2001) and are presented in Table 2. The Cronbach's alpha values of .78 or above across all the three measures of our focal interest indicate a high level of internal consistency for the scale under study. As shown in Figure 1, the sign and magnitude of the factor loadings and positive inter-factor correlations are consistent with our expectations. The variance extracted for each construct (i.e., the common variance shared by the indicators) is above .50. The evidence all together supports the reliability and validity of each construct.

The second objective was to investigate the influence of socio-cultural variables on betel nut chewing behaviors among Chamorro and non-Chamorro Micronesians on Guam.

### Structural Equation Modeling

We also conducted an SEM analysis to examine the effects of three socio-cultural factors related to chewers' chewing behaviors, whether they chew betel nut every day and what type of betel nut they chew. Results of various fit indices are as follows:  $\chi^2$  (55, N=374) = 68.55 with  $p = .10$ , TLI=.94, CFI=.95, WRMR (Weighted Root-Mean-square Residual) =.74, RMSEA = .03 with 90% CIs [.00, .04] and the probability that RMSEA is smaller than .05 is .99. All the evidence suggests that our hypothetical SEM fits the sample data well. As indicated in Figure 2, the standardized path coefficients provide the directions and magnitudes of independent variables' effects on chewing behaviors. For example, a one standard deviation increase in socio-cultural factor, on average, leads to .38 standard deviation increase in the log odds of chewing betel nut every day. As both "whether chewers chew betel nut daily" and "whether they chew mature betel nut" are binary outcomes, all the path coefficients can be interpreted in a similar way. Generally speaking, the younger the participants began chewing, the more likely they were to continue chewing every day. Only the socio-cultural factor among all three factors was positively associated with the participants' current chewing status. As for the type of betel nut that participants chew, older participants tended to chew the mature betel without any ingredients added while younger participants tended to chew the immature nut with ingredients added, which helped to achieve psychological benefits. This SEM can explain 28.20 % of total variance for the variable "whether they chew every day" and 55.00 % of total variance for the variable "whether they chew mature betel nut".

### Intercorrelations among Socio-Cultural Survey Items

The mean and standard deviation results in the second column of Table 3 indicated that the three items for the socio-cultural factor were considered "somewhat important" by participants. The two items for negative consequence were understood as "slightly important." The three items for personal feeling were between "somewhat important" and "very important". All the correlations coefficients are statistically significant at .01 level. The results showed that "I chew because family chew" tended to be highly and statistically



significantly related to “I chew because friends chew” and “I chew because it is part of culture” ( $r = .61$  and  $r = .62$  respectively). The two items, “I chew because it’s rude not to chew” and “I chew because people will not respect me if not chewing” were also highly statistically significantly related to each other ( $r = .78$ ). The three items related to psychological benefits were all significantly correlated with each other ( $r = .59$  to  $r = .79$ ).

## Discussion

Cultural norms are guidelines that define how people are expected to behave within a culture. To be accepted within a culture, people often behave according to what is expected regardless of whether or not the behavior is considered detrimental or negative. In the current study, researchers first examined the extent to which socio-cultural constructs were valid and reliable in the Survey for Betel Nut Chewers. Information regarding socio-cultural factors associated with betel nut chewing can assist in the development of tailored interventions for cessation.

In terms of the first objective, it was found that the socio-cultural model was a sufficient fit with data. This suggests that the Survey for Betel Nut Chewers is a reliable and valid instrument. In relation to the second objective, many researchers have supported the findings of the current study. Griffin (2014), Paulino (2010), and Pobutsky (2012) found that friends and family had a strong influence over whether or not chewers chewed. Chewing in social situations among family and friends was done regardless of known health risks (Griffin 2014). These findings that chewers admitted to chewing in social situations due to peer pressure and the desire to be a part of the group were supported by Murphy & Herzog (2015), Paulino (2010), and Pobutsky (2012). Peer pressure is a very strong social determinant of chewing. People will often engage in behaviors to feel a part of a group and to avoid being ostracized by peers. The feeling of wanting to belong is viewed as a positive outcome (Bandura 1986; Murphy & Herzog, 2015; Paulino 2010).

Social learning theory (Bandura 1986) purports that people learn through observation and modeling of behaviors. When the behaviors observed are perceived to have a positive outcome, then they are modeled (Bandura 1986). In the current study, participants perceived positive outcomes from chewing with their friends and family members and therefore either commenced the behavior or continued it.

Additionally, Murphy & Herzog (2015) and Paulino (2010) found that chewing betel nut was considered to be an extremely important cultural identifier. Chewers stated that chewing and carrying the betel nut bag and ingredients was an important status symbol and identified them as Chamorro or Micronesian (Murphy & Herzog, 2015). People generally are proud of their cultures and like to be identified as part of a group (Bandura 1986).

In the current study it was considered important that chewers chew betel nut in social or cultural situations in order to not be viewed as rude or disrespectful. The concept of respect is highly regarded in the Chamorro and Micronesian cultures. Social cognitive theory (Bandura 1986) and (Griffin 2014) supported this finding. Participants in Griffin (2014)



were more concerned with the social ramifications of not conforming to group behavior than known health risks.

The current study supported the findings of Paulino (2014) in terms of identifying two distinct classes of chewers. We found that the younger population preferred to chew the immature nut and added ingredients. The older population tended to chew the mature nut without any ingredients added. Similarly, Paulino (2014), identified two classes of chewers: Class 1 chewers preferred to chew the mature nut without ingredients added, and Class 2 chewers preferred to chew the immature nut with ingredients added.

### Limitations

When interpreting the results of the current study, several limitations should be taken into consideration. First participants were selected from the Micronesian population on Guam. This may allow for certain assumptions to be made. Results may not be fully representative of all Chamorro and non-Chamorro Micronesian chewers on Guam. Second, the sample size was small we could not conduct a cross-validation to replicate our findings. This will limit the generalizability to Chamorro and non-Chamorro Micronesian populations. Finally, the potential for accuracy of participant responses cannot be confirmed, however, prior studies (Murphy & Herzog, 2015) suggest that misreporting of chewing behaviors is rare in similar populations.

### Conclusion

Serious public health concerns exist with betel nut chewing as it has been categorized as a Group 1 carcinogen by the International Agency for Research on Cancer (IARC 2004a; IARC 2004b; Lin et al. 2008). Also, empirical evidence exists to link the behavior to various forms of cancer (Franke et al. 2014; Oakley, Demaine, and Warnakulasuriya 2005; Shah et al. 2002; Warnakulasuriya 2002a, 2002b). Cultural norms dictate how people behave (Murphy & Herzog, 2015). The results of the current study add to the importance of such findings. Understanding in-depth how behaviors are influenced by social and cultural norms will assist health practitioners to create culturally appropriate risk reduction and cessation programs. Researchers should begin to explore developing such programs.

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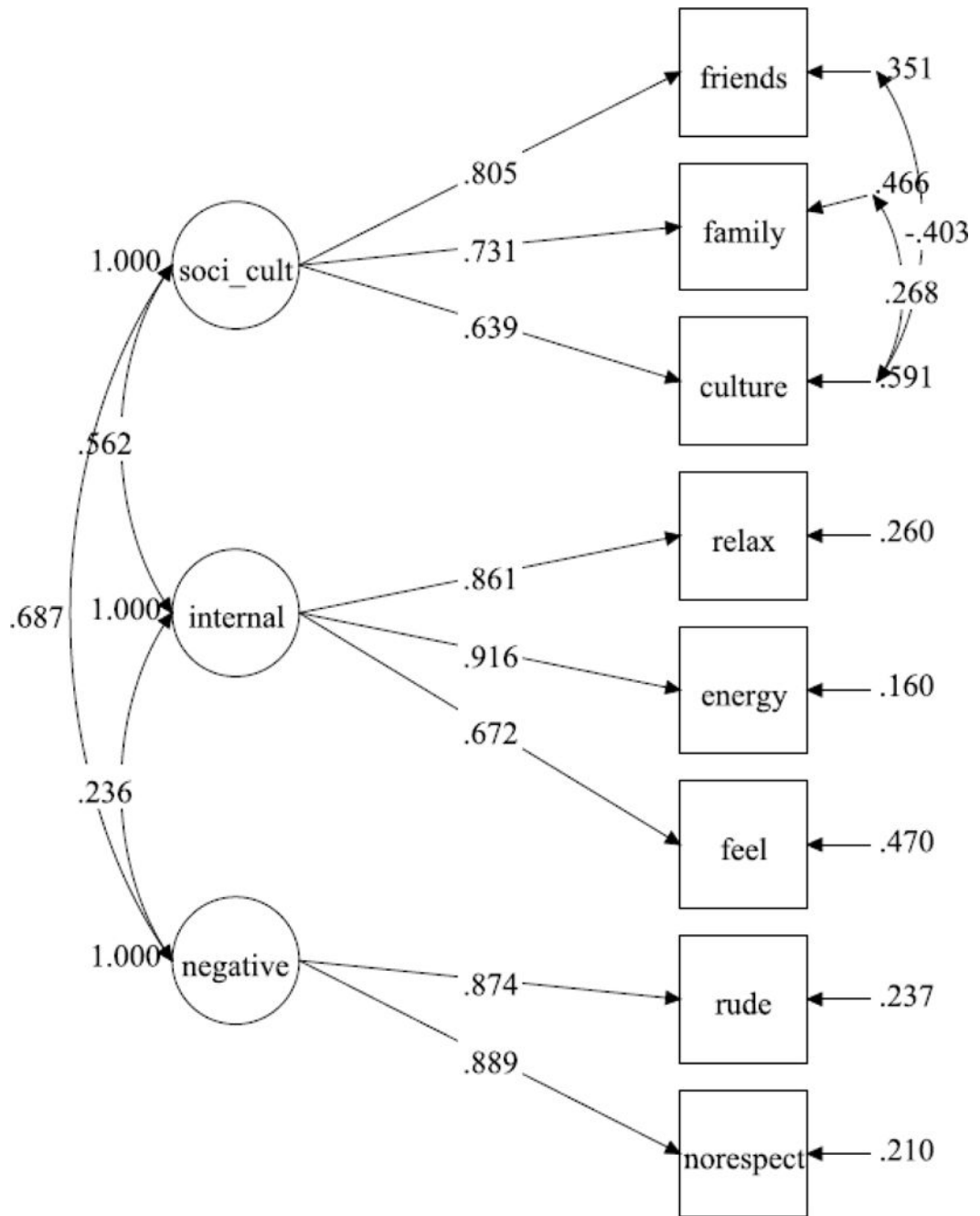
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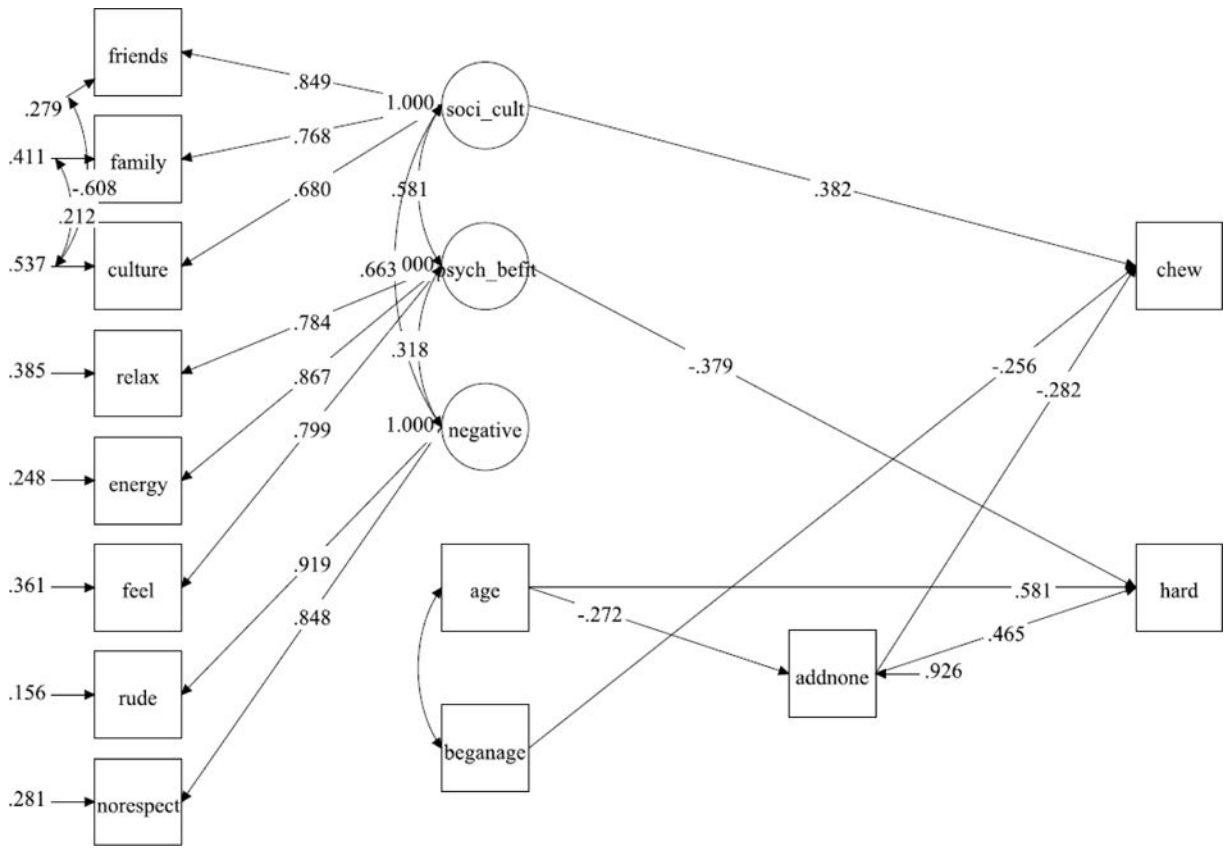
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**Figure 1.**  
Path diagram for standardized CFA model result



**Figure 2.**  
Path diagram for standardized SEM model result

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**Table 1**

Demographic Characteristics of participants in Sample (N=375)

Variable	M	SD	n	%
Age	34.47	20.44		
Age of starting chewing	17.77	8.76		
years of chewing	14.97	12.66		
Gender				
Female			185	49
Male			190	51
Education				
Elementary school			2	.5
Middle school			13	3.5
High school			139	37.1
High school diploma			105	28.0
Some college			71	18.9
Associate's degree			20	5.3
Bachelor's degree			14	3.7
Master's degree			9	2.4
Ethnicity				
Chamorro			124	33.1
Chuukese			109	29.1
Palauan			76	20.3
Yapese			24	6.4
Carolinian			17	4.5
Others			25	6.7

**Table 2**

Correlations among Socio-cultural survey items

	Mean (SD)	1	2	3	4	5	6	7
I chew betel nut or betel quid because all of my friends chew.	1.66 (1.44)							
I chew betel nut or betel quid because my family members chew.	1.74 (1.37)	.607**						
I chew betel nut or betel quid because it is part of my culture.	1.8 (1.55)	.336**	.620**					
I chew betel nut or betel quid because it's rude not to chew.	0.89 (1.36)	.491**	.488**	.430**				
I chew betel nut or betel quid because people will not respect me if I don't chew.	0.75 (1.29)	.469**	.448**	.431**	.780**			
I chew betel nut or betel quid because it relaxes me.	2.56(1.41)	.412**	.375**	.309**	.212**	.161**		
I chew betel nut or betel quid because it gives me energy.	2.52(1.52)	.444**	.360**	.254**	.210**	.187**	.790**	
I chew betel nut or betel quid because I like the way it makes me feel.	2.21(1.56)	.447**	.363**	.159**	.279**	.301**	.591**	.662**

\*\* indicated all coefficients are statistically significant at .01 level.



**Table 3**

Three reliability measures and variance extracted for three socio-cultural factors related to chewing in CFA model

	<b>Cronbach's alpha</b>	<b>F&amp;L</b>	<b>H&amp;M</b>	<b>Variance extracted</b>
Socio-cultural factor	0.78	0.77	0.78	.53
Negative consequence	0.88	0.87	0.88	.78
Internal feeling	0.86	0.86	0.86	.68

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