Association Between Masticatory Performance and Body Mass Index (BMI)

Muslita Indrasari[1]*, Tasya Shakina[2], Chaidar Masulili[1]

1. Department of Prosthodontics, Faculty of Dentistry, Universitas Indonesia, Jakarta 10430, Indonesia.
2. Undergraduate Program, Faculty of Dentistry, Universitas Indonesia, Jakarta 10430, Indonesia.

Abstract

Tooth loss is a major disease of the oral cavity. The primary function of teeth is mastication. Decreasing number of teeth will reduce the masticatory performance and causing food selection, which leads to lack of nutrition. Poor nutrition resulted changes in body mass index (BMI). The aim of this study was to analyze the relationship between masticatory performance and BMI.

A cross-sectional study was conducted on 129 subjects age 34-80 years. Subject was measured of their height and weight, and also interviewed using a questionnaire about masticatory performance and intra oral examination. Chi square was used to analyze the relation between the masticatory performance, tooth loss, denture wearing, age, gender, and economic status with BMI.

Masticatory performance was not significantly associated with BMI (p = 0.96). A significant association was found between age and BMI (p = 0.03). Age affects the body mass index.

Clinical article (J Int Dent Med Res 2016; 9: (Special Issue), pp. 293-298)

Keywords: Masticatory performance, Body mass index, Age, Eichner index.
Received date: 28 September 2016   **Accept date:** 29 October 2016

Introduction

Tooth loss is an irreversible condition. It is the end point of a pathological condition occurs in the mouth. Although the prevalence has declined over the last decade, tooth loss is still the major conditions of the oral cavity around the world.[1] Brazilians reported had a high percentage of edentulism, with a prevalence between 5.2 and 84%, and the major reported numbers were over 60%.[2] The tooth loss prevalence of a cohort study on 3054 subjects of male and female aged over 65 years in northern Italy, was 44%.[3]

According to the World Health Organization (WHO), chronic diseases associated to poor oral health are increasing in developing countries. More specifically, higher levels of edentulousness.[2] Based on Health Research (Riskesdas) in 2013, the index DMF-T (Decay Filling Missing Teeth) in Indonesia reached 4.6. This means that the damaged teeth

*Corresponding author:

Muslita Indrasari
Department of Prosthodontics
Faculty of Dentistry, Universitas Indonesia
Building B Level 3
Jalan Salemba 4 Jakarta 10430, Indonesia
E-mail: muslita.indrasari@ui.ac.id

of Indonesia's population are 460 pieces of tooth per 100 persons. MT (Missing Teeth) index or lost teeth become the largest component of the index, which reached 2.9. This means that the Indonesian population had lost 290 teeth per 100 people, or about 3 teeth per person. The amount of tooth loss is also higher with increasing of age. By the age group, the tooth loss index on the Indonesian population age group of 35-44 years was 3 teeth per person, age group of 45-54 years was 6 teeth per person and age group of 55-64 years was 10 teeth per person. The highest tooth loss in the age group of over 65 years was approximately 17 teeth per person.[4]

The main function of the teeth is mastication[5], the ability to break down food into separate sections, through mastication, thereby enabling the process of swallowing.[6] One of the factors that play a role in the ability of mastication is the number of teeth.[7]

Based on several studies, the number of teeth that less than 20 teeth, with a minimum of 9-10 pairs of teeth are in contact, decreased the efficiency of mastication.[1] A subjectively evaluated study by Singh and Brennan reported decreased in the ability of mastication to be associated with the number of remaining teeth.[8]

A decrease in the ability of mastication will affect the desire to bite, chew and swallow food, that result in the selection of diet and food.[1]

Impaired dental status has often been related to a change in dietary patterns and reduced nutritional intake.[9] Poor nutrition result in changes in body mass index (BMI).[10]

There are few studies on the relationship between the decrease of the masticatory ability due to tooth loss with changes in body mass index (BMI). Results of these studies are conflicting. Some studies reported, decreased masticatory ability related to low BMI levels in elderly women in America. Edentate individuals not wearing dentures were more likely to be underweight.[10] However, in a study stated that there was an increased BMI in elderly with reduced chewing ability due to the loss of teeth.[7] Meanwhile, Kumar et al. stated that no relationship was found between BMI and loss of teeth.[5] Based on the differences results of several research that have been described, it is necessary to study the relationship between masticatory ability and BMI, also several confounding factors, include loss of teeth, denture wearing and socio-demographic factors (gender, age, education level, and economic status).

Materials and methods

Data of this analytic observational cross-sectional study design are collected through several stages, which are the height measurement, weighing, answering questionnaires of mastication ability, as well as the examination of the oral cavity which includes examination of subject's region and the number of missing teeth and denture wearing. The questionnaire used in this study was the ability of mastication questionnaire created by Hanin.[11]

At the time of data collection, researchers supported by 10 research assistants. Calibration performed prior to data collection, so it is expected to have the same understanding of the questions in the questionnaire mastication ability, methods of dental examination, measuring height and weight.

An elderly program in Depok, which is held by the Centre for Ageing Studies, Universitas Indonesia, was chosen as subjects, with consideration of the majority of people who involved in that event were adults and the elderly. Sampling was done using consecutive sampling method. All subjects who came and correspond the inclusion criteria, included in the study until the required number of subjects has fulfilled. Subjects should meet the criteria for inclusion, which are male and female who are able to communicate, because data were collected through interview for questionnaire filling. In addition, the subject should not be impaired mobilization because the subject was expected to come, answer the interview and accomplish the examination. The body mass index (BMI) required height and weight data, then the subject must be willing to be measured of their height and weight. Subjects who were unwilling to sign informed consent and subject unable complete the whole set of this study, categorized into the exclusion criteria.

The sample size in this study was 129 subjects aged 34-80 years were grouped into three age groups based on United Nations[12] and the Ministry of Health[4], which groups adults from ages 20 to 59 years, the elderly or the elderly for 60 to 69 years and elderly at high risk for 70 years and above. Minimum sample size was obtained from the calculation of the value of the 0.05 significance, statistical strength / power of 0.75 and using the software G* Power is equal to 129 subjects. Data were analyzed using SPSS 17. Data analysis methods are univariate data analysis and bivariate analysis with Chi Square.

Results

The univariate data analysis was used to determine the frequency distribution and percentage of each variable to determine a general overview of the subject of the study population. After that, the data is processed using the test bivariate analysis with Chi Square to know the relationship between the variables mastication ability, age, gender, education level, economic status and body mass index (BMI).

	Mean	Median	Standard Deviation	Minimum Value	Maximum Value
Age (years)	59.98	62.00	10.16	34	80
Number of Tooth Loss	7.12	6.00	5.82	0	29
BMI (kg/m²)	25.33	25.28	4.35	15.82	38.78
Expenditure (IDR)	1,829,395	1,500,000	1,326,976	100,000	5,000,000

Table 1. Distribution of Average Age Value, Number of Tooth Loss, Body Mass Index (BMI) and Expenditure.

Based on Table 1, the average age of survey respondents was 59.98 years coming, having lost 7 teeth, overweight (25.28 kg/m²), and the average monthly expenditure was IDR1,829,395.

Variable	Frequency	Percentage (%)
Gender		
• Men	23	17.8
• Women	106	82.2
Age		
• Young adults (20-39)	7	5.4
• Middle age adults (40-59)	42	32.6
• Elderly (60-69)	58	45
• High risk elderly (>70)	22	17.1
Eichner Index		
• A (4 support zone)	55	42.6
• B (1-3 support zone)	68	52.7
• C (no support zone)	6	4.7
Denture		
• No	104	80.6
• Yes	25	19.4
Masticatory Ability Questionnaire		
• Poor (Score <12)	86	66.7
• Good (Score >12)	43	33.3
BMI		
• Underweight (<18.5 kg/m²)	5	3.9
• Normal (≥18.5 - <24.9 kg/m²)	56	43.4
• Overweight (≥25 – 27 kg/m²)	26	21.7
• Obese (≥27 kg/m²)	40	31
Level of Education		
• Elementary (elementary, junior high or equivalent)	31	24
• Secondary (high school or equivalent)	55	42.6
• High (college or equivalent)	43	33.3
Economic Status		
• Expenditure below average (<IDR1,829,395)	72	55.8
• Expenditure above or equal to the average (≥IDR1,829,395)	57	44.2

Table 2. Distribution of Subjects by Gender, Age, Eichner Index, Denture, Masticatory Ability, BMI, Education Level, and Economic Status.

Table 2 shows that the majority of survey respondents were female (82.2%) and the highest percentage was elderly people (45%). A total of 46.5% experienced tooth loss is less than 6, and 52.7% had Eichner index of B category. However, the majority of survey respondents do not wear dentures (80.6%). A total of 66.7% had poor mastication ability, despite that 43.4% had normal BMI (≥18.5 - <24.9 kg / m2). A total of 42.6% have secondary education is high school or equivalent and 55.8% had less spending than the average (<IDR 1,829,395).

Bivariate Analysis

To determine whether there is a significant relationship between mastication ability, gender, age, number of missing teeth, Eichner index, use of dentures, education and economic status and body mass index (BMI), performed bivariate analysis using Chi Square. Terms of Chi Square test is no less than the expected value of 5 is more than 20% of the number of cells. However, the variables age, Eichner index and IMT are categories that are too small. Therefore the merger of categories of variables that can be tested. At the age variable,

the category of young adults and middle-aged adults merged into the adult category. Category C merged with category B on Eichner index. Category skinny combined with normal category on IMT variables.

Based on the diagram in Figure 1, subjects to the masticatory ability of bad and good were lean to normal.
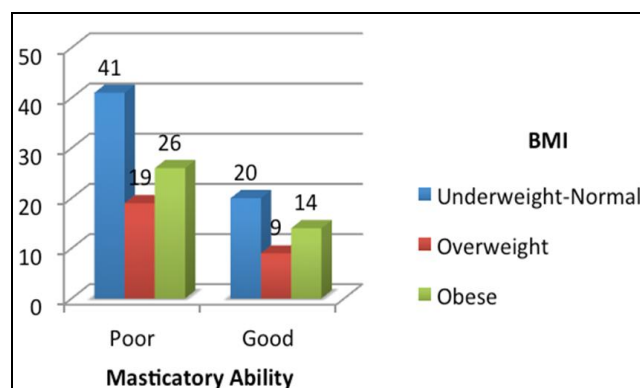
Figure 1. Comparison of Masticatory Ability and Body Mass Index (BMI).

	BMI Category			p-value
	Underweight/ Normal	Overweight	Obese	
Masticatory Ability				
Poor	41 (67.2%)	19 (67.9%)	26 (65%)	0.963
Good	20 (32.8%)	9 (32.1%)	14 (35%)	
Eichner Index				
A	25 (41%)	12 (42.9%)	18 (45%)	0.923
B/C	36 (59%)	16 (57.1%)	22 (55%)	
Denture				
No	47 (77%)	21 (75%)	36 (90%)	0.190
Yes	14 (23%)	7 (25%)	4 (10%)	
Age				
Adults	20 (32.8%)	8 (28.6%)	21 (52.5%)	0.028*
Elderly	26 (42.6%)	14 (50%)	18 (45%)	
High risk elderly	15 (24.6%)	6 (21.4%)	1 (2.5%)	
Gender				
Male	14 (23%)	6 (21.4%)	3 (7.5%)	0.119
Female	47 (77%)	22 (78.6%)	37 (92.5%)	
Educational Level				
Elementary	11 (18%)	8 (28.6%)	12 (30%)	0.281
Secondary	29 (47.5%)	8 (28.6%)	18 (45%)	
High	21 (34.4%)	12 (42.9%)	10 (25%)	
Economic State				
Less than average	35 (57.4%)	16 (57.1%)	21 (52.5%)	0.879
More than average	26 (42.6%)	12 (42.9%)	19 (47.5%)	
* significant (p <0.05)				

Table 3. Analysis of Masticatory Ability, Eichner Index, Use of Denture and Socio-demographic Factors (Age, Gender, Education Level and Economic Status) on the Body Mass Index (BMI).

Table 3 shows the masticatory ability has a significance value of 0.96. Because of the chance of more than 5% (p> 0.05), the masticatory ability did not have a statistically significant relationship with BMI. Total loss of

teeth, Eichner index, use of dentures, gender, education level and economic status also does not have a significant association with BMI. While age has a significance value of 0.028 or less chance factor of 5% (p <0.05) then there is a significant relationship with BMI.

Discussion

This study found no significant association between mastication ability and body mass index (BMI). In the group with BMI slim / normal as much as 67.2% have poor mastication ability. In the group with a BMI obese, 67.9% had a poor mastication ability. A similar trend is also seen in the group with a BMI of obesity as many as 65% also have a poor ability of mastication.

This result is in contrasts with another study that suggested a link between the ability of mastication with BMI.[7,10] The difference is because in this study the ability of mastication was assessed through questionnaires that the answer may be subjective or be accompanied by attitudes and personal expectations. Subjects in this study had no difficulty in chewing food in the mouth, although most of their teeth have been lost, possibly because the subject of manipulation in their food. The manipulation, for example by giving a lot of sauce on the food, so the food becomes softer and does not require mastication in the mouth. On hard foods, the subject will chew slowly in a longer period of time, until the food easier to swallow. It is as described by Witter et al in their study that prolong the time of mastication in the mouth can increase the destruction of solid food.[13] The ability of mastication is also influenced by the conditions mastication muscles, temporomandibular joints, nerves and saliva.[13] Therefore, for further research to evaluate the condition of the muscles of mastication, temporomandibular joints, nerves and saliva subject and its influence on BMI.

Although the result is opposed to Ikebe et al study, this result is in line with the research by Kumar et al. The study states that no relationship was found between BMI and tooth loss in elderly subjects aged 65-85 years. Although the ability of mastication decreased due to loss of teeth, but the consumption of vitamins and fiber remains the same.[5] In this study also found no significant association between teeth lost by category Eichner index with a body mass index (BMI). This is possibly because the body mass index is influenced by several factors such as health problems, consumption of drugs as well as the type of food, so IMT is not only determined by tooth loss alone.[10] Therefore, further study also needed to investigate the influence of the type of food consumed by the subject of the IMT.

In this study, no significant association was not found between the use of denture with a body mass index (BMI). This study is in line with research conducted by Shaikh et al. who stated that there was no significant change in BMI were found in the denture wearer. Fixed oral rehabilitation plays an important role in enhancing the ability to chew food, but not to change one's diet. The use of denture is one of the factors of various other factors that can change the selection of food.[7]

Even so, it is contrary to the results of research by Tsai and Chang who found that the use of removable denture associated with risk of low BMI.[15] As explained by Bessadet et al, reduced masticatory function in patients with lost posterior contact can be improved with the use of removable denture. Nevertheless, the ability of mastication on the denture wearer is not the same as individuals with natural teeth.[16] This differences result due to differences in the distribution of denture category. In the study by Tsai et al, denture category is divided into removable denture, fixed denture and no dentures. This study in the other hand only divide the subject to wear and do not wear dentures, and the obtained amount is unbalanced. In addition, the entire subjects of denture wearer found, were using removable denture and no fixed denture wearer. Patients with removable denture have the ability mastication significantly lower compared with patients with fixed denture or implant.[15] Thus it is necessary to do research with more balanced proportions, both of the number of users and types of denture, because different types of denture possibility of providing a different impact on a person's body mass index.

Results of this study prove that there is a relationship between age and body mass index (BMI). From available data it can be seen that obesity is more common in older age groups (20-59 years) is 52.5% or 21 of 40 subjects. While the body fat and lean / normal is more common in older people (60-69 years). In this study, the tendency of BMI decreased with age. The results are consistent with research by De Marchi et al which states increasing age was associated with

decreased body mass index.[17] Yoshida et al also found that consumption of food and micronutrients such as vitamin C, vitamin E, riboflavin, thiamin and folic acid is low in the age group 65 years and over.[18] In addition there is also a decrease in muscle mass, organ tissue, skin and bones with age. It is as described in the study Flores-Orozco et al who found a significant decrease between BMI due to a decrease in muscle mass in the elderly.[19]

In this study found no significant association between gender and body mass index (BMI). This contrasts with De Marchi et al, that women are more likely to have a higher BMI than men.[17] As described by another study, female are more prone to obesity because they have fat accumulation in the abdominal cavity organs (visceral fat) were more than in male, the difference in food intake and a higher life expectancy.[10] Differences in the results of this study could be due to the number of male and female were less balanced. In the study of De Marchi et al, the percentage of the number of male were 42% and female were 58%. While in this study the majority of subjects which 77% are female. Therefore further research should be done with the proportion of gender is more balanced.[17]

In this study found no significant association between education and body mass index (BMI). As proposed by Devaux et al, the level of education will increase a person's access to health information and the ability to implement it. Awareness of the risks related to a person's lifestyle choices are also larger and increase the ability to control themselves consistently.[20] This is consistent with In-Hwan et al, who found the influence of education on reduction in BMI in Korea. Based on these studies, the higher a person's education, the higher a person's well awareness against health problems associated with obesity and the more healthy lifestyle.[21] The difference in the results of this study could be due to differences in the category of educational level used. In this study, subjects were classified based on education last formal education in Indonesia, namely basic education (elementary and junior high school or equivalent), secondary education (high school or equivalent) and higher education (university or equivalent).[22] While In-Hwan et al used a classification based on the number of years of school is 6 years, 7-12 years and 13 years or more.[21]

In the results of this study found no significant association between economic status and body mass index (BMI). Households expenditure consisting of food and non-food expenditure can describe how people allocate their household needs.[23] As stated by In-Hwan et al, income is the most important thing that affects a person's ability to spend food and physical activity.[21] This is probably because most of the subjects were retired that expenditure of each month was not so much, because of basic necessities such as food daily has been provided by their family. This can explain the tendency of subjects with a BMI of good, but the economic level below average.

In this study, it appears the relationship between age and body mass index BMI and trends that declines with age. Therefore, it is necessary to have a socialization for the elderly in order to maintain a diet with foods and drinks adequate and nutritious. Additionally, in this study the percentage tooth loss was quite high, but the use of denture was still low. Therefore, it is necessary also increase education and awareness of maintaining oral health and the importance of oral rehabilitation.

The weakness of cross-sectional design is susceptible to bias. Bias that can occur in this study is recall bias and interviewer bias.[24] Recall bias is a bias due to memory on the subject of past events that can occur when answering the mastication ability questionnaire, for example, the time required for mastication. Interviewer bias is a bias that comes from the interviewer. This can happen due to a lack of understanding of the questions in the questionnaire interviewer. But in this study, has been cultivated anticipation by training how to conduct interviews helper researchers able to help subjects answered questionnaires, and interviewers calibration in order to have a common understanding of the questions on the questionnaire mastication ability as well as procedures for their use. By doing this calibration, interviewers are trained to get good answers reliability of the research subjects. Calibration is done by filling out the mastication ability questionnaire guidelines created by Hanin.[11] Examination and data collection processes gradually lead to fatigue interviewer in exploring answers, and fatigue subjects in answering questions. Fatigue can reduce the level of concentration that affects the accuracy of the data obtained. This was overcome by

conducting interviews effectively and efficiently, perform checks quickly and accurately as well as a comfortable sitting position.

In this study the mastication ability of research subjects were measured through answering the questionnaire so that the answers given tend to be subjective.[24] This can be overcome by using a tool that can measure objectively mastication ability. Furthermore cross sectional study requires research subjects in large numbers. The greater number of subjects will increase the strength of the research. The research strength of this study is only 75% with a sample of 129. The strength of the study $(1 - \beta)$ is the ability of a study to reject the null hypothesis if it really wrong that is no relationship between the variables. Therefore, the greater the strength of the research will be more likely to find the relationship of these studies.[25] In addition, subject distribution less evenly on the user and the type of denture, gender and the amount of expenditure can affect the data obtained. Therefore, it is advisable in future studies to increase the number of subjects, as well as researched by areas or different communities with more balanced comparison denture wearer and type, number of gender and economic status.

Conclusions

Based on this study, it can be concluded that there is a relationship between one of socio-demographic factors, namely age and body mass index (BMI). There was no relationship found between mastication ability, loss of teeth, denture use, and several socio-demographic factors, such as gender, education and economic level, with the body mass index.

Acknowledgements

Declaration of Interest

The authors report no conflict of interest.

References

1. Emami E, De Souza RF, Kabawat M, Feine JS. The Impact of Edentulism on Oral and General Health. *Int J Dent.* 2013.
2. I. Urzua, et al. Dental Caries Prevalence and Tooth Loss in Chilean Adult Population: First National Dental Examination Survey. International Journal of Dentistry. 2012
3. Khazaei S, Firouzei MS, Sadeghpour S, et al. Edentulism and Tooth Loss in Iran: SEPAHAN Systematic Review No. 6. *Int J Prev Med.* 2012;3(1):S42-7.
4. Badan Penelitian dan Pengembangan Kesehatan RI. *Riset Kesehatan Dasar (Riskesdas) 2013.* Jakarta: Kementrian Kesehatan RI; 2013.
5. Kumar D, Rastogi N, Madan R. Correlation between Health and Nutritional Status in Geriatric Population. *World J Dent.* 2012;3(4):297-302.
6. Ikebe K, Matsuda K, Kagawa R, et al. Masticatory Performance in Older Subjects with Varying Degrees of Tooth Loss. *J Dent.* 2012;40(1):71-6.
7. Shaikh S, Aziz F, Javed MU, Saeed MH Bin, Sharif M, Azad AA. Body Mass Index Before and After Provision of Complete Dentures. *Pakistan Oral Dent J.* 2012;32(2):335-340.
8. Singh K, Brennan DS. Chewing disability in older adults attributable to tooth loss and other oral conditions. *Gerodontology.* 2012;29(2):106-10.
9. Anastassia Kossioni, et al. Eating habits in older people in Greece: The role of age, dental status and chewing difficulties. *Archives of Gerontology and Geriatrics.* 2011;(52):197–201
10. Tôrres LHDN, da Silva DD, Neri AL, Hilgert JB, Hugo FN, Sousa MDLR De. Association between underweight and overweight/obesity with oral health among independently living Brazilian elderly. *Nutrition.* 2013;29(1):152-157.
11. Hanin I. Hubungan Kemampuan Mastikasi (Analisis Menggunakan Kuisioner Kemampuan Mastikasi) dengan Kualitas Hidup Wanita Pra-Lansia dan Lansia [Thesis]. 2012:1-33.
12. Departement of Economic and Social Affairs. *World Population Ageing 2013.* United Nations Publication; 2013:ST/ESA/SER.A/348.
13. Dick J. Witter, et al. Clinical interpretation of a masticatory normative indicator analysis of masticatory function in subjects with different occlusal and prosthodontic status. *Journal of Dentistry.* 2013;41:443-448
14. A. Van Der Bilt, et al. Assessment of mastication with implications for oral rehabilitation: a review. *Journal of Oral Rehabilitation.* 2011; 38(10):754-780.
15. Tsai a C, Chang T-L. Association of dental prosthetic condition with food consumption and the risk of malnutrition and follow-up 4-year mortality risk in elderly Taiwanese. *J Nutr Health Aging.* 2011;15(4):265-70.
16. Bessadet M, Nicolas E, Sochat M, Hennequin M, Veyrune J-L. Impact of removable partial denture prosthesis on chewing efficiency. *J Appl Oral Sci.* 2013;21(5):392-6.
17. De Marchi RJ, Hugo FN, Hilgert JB, Padilha DMP. Association between number of teeth, edentulism and use of dentures with percentage body fat in south Brazilian community-dwelling older people. *Gerodontology.* 2012;29(2):e69-76.
18. Mitsuyoshi Yoshida, et al. Correlation between dental and nutritional status in community-dwelling elderly Japanese. *International Geriatric and Gerondotology.* 2011; 11(3):315-319.
19. Flores-Orozco E. I., et al. Lack of relationship between masticatory performance and nutritional status in adults with natural dentition. *Archives of Oral Biology.* 2016; (71):117-121.
20. Devaux M, Sassi F, Cecchini M, Borgonovi F, Church J. Exploring the Relationship Between Education and Obesity. *OECD J Econ Stud.* 2011;2011(1):1-40.
21. In-Hwan Oh, Youngtae Cho2, So-Youn Park3, Changmo Oh1, Bong-Keun Choe1, Joong-Myung Choi1, and Tai-Young Yoon. Relationship Between Socioeconomic Variables and Obesity in Korean Adolescents. J Epidemiol 2011;21(4):263-270
22. Badan Pusat Statistik. Pendidikan Penduduk Indonesia : Hasil Sensus Penduduk 2010. Jakarta: Badan Pusat Statistik; 2011:7-15.
23. Kementrian Kesehatan Republik Indonesia. *Profil Kesehatan Indonesia 2012.* Jakarta: Kementrian Kesehatan RI; 2013.
24. Notoatmodjo S. *Metodologi Penelitian Kesehatan.* Jakarta: Rineka Cipta; 2010:150-151.
25. Larry B. Christensen. R. Burke Johnson. Lisa A. Turner. *Research Methods, Design, and Analysis 12th Ed*; 2014.