The Alameda County Study:
A Systematic, Chronological Review

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ABSTRACT

This study is a systematic review of the Alameda County study findings and their importance in establishing a link between lifestyle and health outcomes. A systematic review of literature was performed and data indicating important links between lifestyle and health were synthesized. Although initial studies focused on the associations between health outcomes and personal health habits known as the "Alameda 7," subsequent studies focused on the relationships between social variables, religiosity, several chronic health problems, and long-term health. Significant findings during periodic assessments of the original 1965 cohort yielded strong support for a link between lifestyle habits and long-term health outcomes. Additionally, social networks, religiosity, and several demographic variables were found to be associated with chronic disease development.

INTRODUCTION

In 1965, life expectancy reached a point at which quality, not merely existence, deserved attention.[1] In an effort to discover the effect of personal health habits on quality of life, chronic conditions, and mortality, several researchers in California developed the Human Population Laboratory. The group of researchers decided on a design to measure select health practices among a probability sample of the population of Alameda County in California. The participants answered initial survey questions concerning their lifestyle habits in 1965 with subsequent collections taking place in 1973, 1985, 1988, 1994, and 1999.

DEVELOPMENT OF THE "ALAMEDA 7"

The 1965 panel, known as the Health and Ways of Living panel, included Lester Breslow, Nedra Belloc, and George A. Kaplan. Breslow and Kaplan became the principal investigators of the Health and Ways of Living Study, with Belloc making major contributions to initial studies. Much of the continued study of health behaviors occurred at the Human Population Laboratory in Berkeley, California.

In an attempt to assess the effects of health habits and social relationships on physical and mental health, Belloc and colleagues[1] obtained information from 6,928 respondents in Alameda county. The probability sample included 3,158 men and 3,770 women. The sample included 360 men and 530 women over the age of 65. This sample would become known as the 1965 Alameda cohort. Each participant answered surveys regarding marital and life satisfaction, parenting, physical activities, employment, childhood experiences, and demographic data. In addition, participants were asked to report levels of disability "without complaints," "symptomatic," "chronic conditions," "disability-less," and "disability-severe." To summarize physical health status of groups of individuals, weighted proportions were necessary. Therefore, each group was classified by a *ridit,* or Relative to an Identified Distribution, allowing feasible and meaningful comparisons between groups.

Belloc and colleagues[1] published the initial set of findings from the 1965 Alameda cohort. Self-reported disability data revealed fewer men were disabled than women, but the proportion of chronic diseases was nearly equal. Occurrence of disability and chronic disease increased with

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age, and high-energy levels were found mostly in younger groups. In an overall comparison between groups, men were healthier than women, younger people (45 years or less) were healthier than older people (over 45 years), and individuals with inadequate income were less healthy than individuals with adequate income. Furthermore, those who were employed were healthier than those who were unemployed or retired. White and black persons were equally healthy, but Chinese and Japanese individuals displayed a favorable status not related to age, sex, or income. Persons with higher education levels were healthier than those with less education, and separated persons were less healthy than those who were married. Several of these health disparities including educational level and marital status continue today.

Belloc and colleagues[2] published a follow-up study that examined the relationship between physical health status and health practices. Using data from the 1965 Alameda cohort, Belloc and colleagues[2] examined nightly hours of sleeping, regularity of meals, physical activity, alcohol consumption, and smoking. Additional analyses were performed to determine if these health behaviors had independent or cumulative effects on health outcomes. The results revealed that sleeping seven to eight hours per night, eating regular meals, participating in regular exercise, limiting alcohol consumption, and not smoking were highly correlated with healthier individuals. In contrast to previous studies, socioeconomic status was found to have no association with health. Further data analyses suggested a cumulative effect of these behaviors. This study provided initial empirical support for the link between lifestyle and health outcomes.

In a 5-1/2 year follow up of the 1965 Alameda cohort, Belloc[3] investigated the relationship between health practices and mortality. Health practices included sleep, weight, smoking, eating, alcohol consumption, physical activity, and other health practices. Analysis of results revealed that those who ate regular meals including breakfast,

received adequate sleep (7–8 hours), maintained a healthy weight for their height, did not smoke, limited alcohol consumption, and participated in regular physical activity lived longer than those who did not practice these behaviors. These seven healthy behaviors would become known as the "Alameda 7." In a final analysis, men and women practicing six of the seven health behaviors lived 11 and 7 years longer, respectively, than those practicing fewer than 6 health behaviors. Belloc[3] concluded that there was a striking inverse correlation between the number of health practices and mortality levels for older age groups.

These initial studies provided data indicating a relationship between personal health habits (Alameda 7) and health outcomes. Additionally, data indicated health disparities based on demographic variables including socioeconomic status, ethnicity, age, and educational level. Analyses of subsequent data collections in 1973, 1985, 1988, 1994, and 1999 would continue to support the conclusions. Additional studies would expand on these findings to determine links between social interactions, religiosity, obesity, and other chronic conditions.

FOLLOW-UP STUDIES

In an attempt to further establish understanding of the relationship between health behaviors and quality of life, Gottlieb and colleagues[4] examined the "Alameda 7" health behaviors, life events, and social networks. Data from the 1965 Alameda cohort were analyzed in an attempt to correlate income, educational level, age, five health practices, social networks, and life events. Although some of the analyses were inconclusive, there was a positive relationship between social networks and health practices for both men and women. Furthermore, church participation and marriage were positively correlated with health outcomes. These findings supported the belief that social networks and certain elements of spirituality were associated with long-term health outcomes.

In a 9-1/2 year follow up of the 1965 Alameda cohort, Breslow and colleagues[5]

examined the "Alameda 7" health habits and mortality. The results supported the hypothesis that good health practices and not the initial health status of the survey respondents are largely responsible for the observed mortality rates. Although no health practice behaviors had been measured in five years, it was assumed that most individuals were consistent with regard to health practices. In a similar follow-up study, Wiley and colleagues[6] found significant correlations between the "Alameda 7" health behaviors and positive health outcomes.

Roberts and colleagues[7] used data from the 1965 cohort to specifically differentiate health practices based on ethnicity. The health practices of Anglo, African-American or African, and Chicano people were compared within the 1965 Alameda cohort. Age, sex, family income, education, marital status, perceived health status, and physical health status were assessed. In general, Chicanos reported less disability, fewer chronic conditions, and fewer symptoms of ailments. However, in contrast to other ethnic groups, higher levels of severe mortality were found among Chicano women. Overall, Chicanos health practices and conditions compared favorably to Anglos and people of African descent. Furthermore, the data analyses supported previous hypotheses that good health practices were associated with a longer and better quality of life.

Using a multivariate analysis of the seven health behaviors and seven demographic variables identified by previous Human Population Laboratory studies, Wingard and colleagues[8] converted nine-year mortality rates and health practice *ridits* into *logits* (log odds units). By converting the previous ridit scores to logits, researchers were able to make linear comparisons. In nearly all age groups and health practice groups, five of seven health behaviors were significant and independently associated with mortality. In contrast to previous studies, eating breakfast and snacking between meals had no substantial association with mortality. The linear model supported previous findings, indicating regular exercise,

limited alcohol consumption, abstinence from smoking, sleeping 7–8 hours a night, and maintenance of a healthy weight play an important role in promoting longevity and delaying illness and death.

Mortality, behavioral, and demographic risk factors among older people (over 65 years) in the 1965 Alameda cohort were examined in 1987. Kaplan and colleagues[9] reexamined health practices of the older people (>65 years of age) in the 1965 cohort and compared current levels of health practices and demographic factors to baseline data. Results indicated many behavioral and demographic risk factors remained predictors of seventeen-year mortality risk, even at older ages. In a multivariate analysis of the "Alameda 7" health behaviors, Kaplan and colleagues[9] found strong negative associations between the "Alameda 7" health behaviors and cancer, heart disease, stroke, diabetes, high blood pressure, and trouble breathing. Ethnic disparities in mortality risk decreased with age, and eating breakfast was more strongly associated with positive health outcomes in older groups. This study provided evidence that the relationship between health practices and mortality was consistent over time.

In the most recent studies concerning the "Alameda 7" health behaviors and mortality, Strawbridge and colleagues[10] and Beebe-Dimmer and colleagues[11] examined self-rated health and disease burden factors during childhood, and the association between socioeconomic and mortality among adults in the 1965 Alameda cohort, respectively. Strawbridge and colleagues[10] tested the hypothesis that personal health behaviors could not predict mortality. After current conditions of the 1965 Alameda cohort were discovered and analyzed, researchers concluded mortality could not be predicted by health behaviors alone. However, personal health practices were still the largest predictor of mortality. Beebe-Dimmer and colleagues[11] concluded lower childhood socioeconomic status was associated with an increased mortality due to cardiovascular disease, but was unrelated

to death due to other causes. Overall mortality rates were highest among women with low educational levels, and low household income was associated with higher cardiovascular disease. Furthermore, low socioeconomic status in early and later life contributed to an increased mortality risk in women. These effects were stronger for cardiovascular mortality than non-cardiovascular mortality.

From 1979 to 2004, continued analyses of subsequent data collections from the 1965 cohort continued to support the hypothesis that the "Alameda 7" health behaviors are strongly associated with long-term health outcomes. Although recent studies have found no significant correlations between not eating breakfast or snacking between meals and health outcomes, the remaining five have consistently been shown to be associated with good health.

RELATED STUDIES

Several researchers attempted to determine the generalizability of the Alameda county study findings using regional and national samples. Brock and colleagues[12] attempted to replicate the Alameda longitudinal study in Michigan. A statewide sample of 3,259 adult Michigan residents were surveyed regarding their health practices via telephone. Consistent relationships were found between physical health status and individual health practices, including sleep patterns, eating breakfast, eating between meals, smoking, weight, and physical activity. However, some of the findings, such as sleeping 7–8 hours, eating breakfast and eating between meals, were not found to be statistically significant. Although not all health practices were significant, the results demonstrated the generalizability of the Alameda county study.

In an effort to identify prevalence of the "Alameda 7" health practices nationwide, Schoenborn[13] reported results from the 1985 National Health Interview Survey (NHIS). Questions from the NHIS asked a nationwide sample about their exercise habits, eating habits, sleeping habits, alcohol consumption, body weight, and demo-

graphic characteristics. Although some variables were defined slightly differently, the author reported results regarding the "Alameda 7" health behaviors. Simple prevalence statistics, unadjusted for age or other sociodemographic characteristics, were used in the analysis. Results of the survey revealed 12 percent of men and 11 percent of women practiced six or seven good health habits, more than half of both men and women reported 4 or 5 "good health" habits, and 37 percent of men and 33 percent of women reported 0 to 3 "good health" habits. Men were more likely to smoke, consume alcohol, and exercise than women. Younger people (18–44 years) were more likely to skip breakfast, snack between meals, and drink alcohol than older persons (over 45 years). Caucasians were more likely to eat breakfast, sleep 7–8 hours, and drink five or more drinks at one sitting than African-Americans. Additionally, persons in socially and economically disadvantaged groups were less likely to have "good health" habits. Persons in older groups were more likely to have a greater number of "good health" habits, and African-Americans tended to have fewer "good health" habits than Caucasians. These results showed disparities among social, economic, ethnic, and age groups with regard to health practices.

The results of these studies supported previous findings using data from the 1965 Alameda cohort. Positive correlations were found between the "Alameda 7" health behaviors and positive health outcomes. Additionally, similar disparities were found based on ethnicity, gender, socioeconomic status, and educational level. These studies indicated the generalizability of the Alameda county study findings, and further established personal health practices as major factors in long-term health.

In addition to establishing the link between personal health practices and health outcomes, researchers have attempted to determine the relationship between social interactions, religiosity, depression, obesity, hearing and vision loss, and other chronic conditions.

SOCIAL/MARITAL RELATIONSHIPS

Several follow-up studies involving the 1965 cohort focused on the relationships among marriage, social interactions, and mortality. Kotler and colleagues[14] concluded marital status is associated with health outcomes. Married individuals, especially men, had lower mortality risk than single individuals, and divorced or separated individuals had highest risk. Data analyses performed by Reynolds and colleagues[15] indicated a negative relationship between social connections, incidence of mortality, and prognosis of cancer. Although this study was limited by the complexity of the variables involved, the relationship between social connections and reduced risk for cancer was found significant. In addition, Yen and colleagues[16] indicated lower-quality social environments were associated with an increased risk of death during an eleven-year follow up. The association remained after adjustments for age, sex, income, education, race/ethnicity, smoking, body mass index, alcohol consumption, and perceived health status were made.

RELIGIOSITY

In addition to studies tracking specific health behaviors of the Alameda cohort, several authors have examined social, economic, and psychological factors related to health practices. Strawbridge and colleagues[17] and Oman and colleagues[18] studied religious attendance (weekly, monthly, yearly, never) and its association with mortality and survival. Using data collections from 1965, 1973, 1985, 1988, and 1994, researchers examined spirituality, religion, and mortality. Results of these studies indicated high levels of religious involvement are associated with lower rates of death by specific causes including circulatory diseases, digestive diseases, respiratory diseases, and all causes combined. Additionally, wide ranges of other chronic diseases were inversely correlated with attendance of a religious event (weekly, monthly, yearly, never). Results indicated that for women the protective effect of weekly attendance at a religious event was strong and fell roughly between never smoking cigarettes and regular physical activity. More moderate effects were found for men. In support of these findings, Strawbridge and colleagues[19] concluded that those reporting weekly religious attendance were more likely to improve poor health behaviors and maintain good health behaviors. Weekly religious attendance was also associated with good mental health and social relationships. Again, the relationship was stronger among women.

DEPRESSION AND OBESITY

Several researchers have attempted to determine the relationship between health status and psychological disorders. After reviewing data from the 1965 Alameda cohort, Roberts and colleagues[20] concluded there was no evidence to suggest that depression is associated with an increase in all-cause mortality. In contrast, Camacho and colleagues[21] stated that men and women with low activity levels at baseline were at a significantly greater risk for depression at the 20-year follow-up than those who reported high activity levels. Yen and colleagues[22] indicated that residence in a poverty area was associated with declining perceived health, but risk for developing high levels of depressive symptoms was not significantly different for those not living in a poverty area.

The most recent studies regarding depression focused on the relationships between physical activity, obesity, and depression. Using data collected from the 1965 cohort in 1994 and 1995, Roberts and colleagues[23] indicated mixed results regarding the relationship between obesity and depression. Researchers indicated greater odds for depression in obese individuals in 1994, and obesity in 1994 predicted depression in 1995. Although the results of the prospective analyses were not significant, the results suggested an association between obesity and depression.

Strawbridge and colleagues[24] used data from 1994 and 1999 to access the relationship between physical activity and depression in older adults (50 to 94 years). After adjusting for age, sex, ethnicity, socioeconomic status, chronic conditions, disability, body mass index, alcohol consumption, smoking, and social relations, authors revealed that physical activity was protective for both prevalent and incident depression. Using data collected in 1995 and 1999, Roberts and colleagues[25] investigated the reciprocal effect of depression on obesity. Results indicated obesity in 1995 was associated with an increased risk for depression in 1999, but depression did not increase the risk for future obesity.

HEARING AND VISION LOSS

Research suggests hearing and vision loss is increasingly common among older persons and is negatively associated with well-being.[26] Using data collected in 1994 and 1999, researchers assessed the impact of hearing and vision loss on subsequent disability, physical functioning, mental health, and social functioning.[27] Both hearing and vision loss had significant negative impacts on quality of life. Specifically, physical functioning and social interaction abilities were greatly impaired. Although this study supported previous findings,[28] little was known about the effects of hearing loss on one's spouse.

Wallhagen and colleagues[29] investigated the relationship between a spouse's hearing loss and his or her partner's physical, psychological, and social well-being. Using data collected in 1994 and 1999, researchers concluded that a husband's hearing loss greatly increased the likelihood of subsequent decreases in physical, psychological, and social well-being in their spouses. The relationship between wives' hearing loss and husbands' subsequent decreases in well-being was weaker, but significant.

SLEEP DISTURBANCE

Sleep problems are relatively common among older persons and may have a significant negative impact on well-being.[30] Roberts and colleagues[31] analyzed data collected in 1995 and 1999 from the 1965 cohort to assess the prevalence of sleep complaints and the relationship between sleep problems and health outcomes. Insomnia

was reported by 23.4% of participants in 1994 and incidence of insomnia and hypersomnia (too much sleep) increased with age. Women reported greater sleep disturbance and insomnia was strongly correlated with chronic disease. Recently, Strawbridge and colleagues[32] investigated the impact of a spouse's sleep problems on his or her partner. Data collected in 1999 from the 1965 cohort were analyzed to determine the effects on spousal sleep disturbance on partners' physical health, mental health, well-being, social involvement, and marital quality. Although associations between sleep disturbance and one's own health outcomes were stronger, spousal sleep problems were associated with a partner's poor health, depression, unhappiness with social relationships, and unhappy marriages.

CHRONIC DISEASES

Some of the most recent findings from the 1965 cohort have provided further evidence for the relationship between chronic diseases and the "Alameda 7" health behaviors. Seavey and colleagues[33] examined risk factors associated with self-reported arthritis symptoms in a 20-year follow-up. Authors found significant associations between arthritis and age (>45 years of age), BMI, sex (female), and depressive symptoms. Physical activity was found to have protective effects on development of arthritis. Kotz and colleagues[34] investigated the effect of osteoporosis on physical and mental outcomes in the 1965 cohort. Participants with osteoporosis were more likely to report frailty, difficulty with balance, weakness, fair/poor perceived health, and not enjoying free time. Research suggests frailty and weakness are associated with reduced physical activity, poorer mental health, and lower quality of life.[35]

CONCLUSION

Although the last data collection of the 1965 Alameda cohort occurred in 1999, additional current analyses continue to provide supporting results indicating a link between personal health behaviors, social interactions, socioeconomic status, educational level, and long-term health outcomes, quality of life, and mortality. Initial findings of the Alameda county study along with subsequent studies form the basis for much of what we know and practice in health education and promotion. This work has firmly established lifestyle as a major determinant of health outcomes in the United States and reinforces the beliefs of health professionals that healthy behaviors are necessary in maintenance and improvement of health status. Breslow, a principal investigator of the Alameda county study, stated:

> "A step beyond treatment and even the prevention of disease is coming onto the health agenda: health promotion or the advancement of well-being and the avoidance of health risks by achieving the optimal levels of the behavioral, societal, environmental and biomedical determinants of health. Health promotion is aimed at maintaining the level of health and, insofar as possible, strengthening the potential resources for health."[36]

Studies using data from the 1965 cohort since these comments by Breslow continue to support healthy behaviors as a preventative factor in long term health outcomes. Further data analyses over the past 5 years have expanded our knowledge of the original 'Alameda 7' and have shown the impact of social interactions, elements of spirituality, hearing/vision loss, and sleep disturbance on health outcomes.

Health promotion as a profession continues to develop and expand as findings from the Alameda county study reinforce lifestyle as a determinant in long-term health. Health professionals continue to focus on these health behaviors, including the "Alameda 7." Other variables identified as being associated with a healthy lifestyle, such as social, spiritual, and demographic variables have begun to receive greater attention. Although efforts of health promoters and other health professionals have impacted some behaviors, other negative health behaviors remain prevalent. Surveys indicate declining rates of smoking and use of other tobacco products since 1983.[37] Mixed results are seen in other areas, such as physical activity and nutrition. For example, recent studies regarding programs such as the coordinated approach to child health (CATCH) indicate improvement in eating habits and physical activity level in some school-aged children[38]. However, 77.4% of adults report consuming fewer than 5 servings of fruits and vegetables daily,[39] and 73.7% of adults do not meet recommendation for physical activity.[40] Recent data indicate that the incidence of obesity continues to rise in all age groups,[41] and insufficient sleep is becoming more common with adults, who are averaging 6.9 hours per night.[42]

Other variables related to long-term health such as demographic variables (e.g., age, gender, etc.), social networks, and spirituality have not been fully addressed. Buchanan[43] suggests it is our social surroundings that impact us most. Therefore, healthy individuals will develop from a society that values health. It may be the lack of societal value placed on preventative health behaviors that encourages negative health practices. Efforts forged by health professionals to raise awareness of health issues have been successful in some areas (i.e., cancer screenings), but have had limited impact in others (i.e., regular exercise, fruit and vegetable consumption).[43] In the future it will be necessary for health professionals to advocate for healthier policies, and to bring greater awareness of healthy behaviors to the general public.

As researchers continue to discover relationships between lifestyle and health outcomes, it is imperative that health promoters and other health professionals focus on the most pressing issues. Obesity, physical inactivity, poor dietary habits, and insufficient sleep are becoming more prevalent. The relationships among diet, exercise, and body weight are well established, and results from several recent studies suggest inadequate sleep as a factor in an unhealthy body weight. With fewer than half of Americans reporting sufficient sleep,[44] the relationship

between sleep and body weight may be vital to solving the obesity problem in the United States.

The various studies associated with the Alameda county project helped to form the basis of a major public health shift in our approach to disease prevention and longevity. As more has been learned about the impact of lifestyle on disease and death, public health programming has become more focused on helping the public achieve these lifestyle objectives. There is still much work to be done. While the Alameda county project has had an impact on our past, its findings must also inform our future public health activities. In the future, health professionals should continue to improve programs to raise awareness of prevalent health issues and measures that may be taken to prevent negative health outcomes. Additionally, health professionals should focus on reducing negative health outcomes by attempting to provide methods aimed at increasing the prevalence of the "Alameda 7" health behaviors.

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