

Common Modifiable and Non-Modifiable Risk Factors of Cardiovascular Disease (CVD) among Pacific Countries

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Abstract

Introduction: Modifiable and non-modifiable risk factors contribute to the significant rise of non-communicable diseases (NCDs), most notably cardiovascular disease (CVD), in the Pacific Island nations. The aim of this study is to review previously published articles to understand common modifiable and non-modifiable risk factors of CVD among Pacific countries. **Methods:** This systematic review is conducted using different databases including; Scopus, Medline, EMBASE, and psycINFO. This systematic review is based on the Cochrane review process. All articles published in the English language from 1st January 2000 to 1st September 2016, will be included in the study. After reviewing all of the articles' titles, abstracts, and full text, the final articles were reviewed and the relevant data was included in the data extraction sheet. A descriptive analysis was conducted to measure the common risk factors of CVD in Pacific countries. **Results:** Overall, 45 articles met the inclusion criteria of the study. The results showed that age was the most common non-modifiable risk factor while diabetes, high blood lipid, and high blood pressure were the most common modifiable risk factors of CVD. There were only three interventional studies which had all of the significant influences in reducing the risk factors of CVD when the results were compared with the control group. **Conclusion:** While it is not possible to change the non-modifiable risk factors for CVD, we encourage policy makers to use the results of this study to develop health promotion strategies to address the modifiable risk factors for CVD. Interventional strategies are highly recommended in the Pacific countries to tackle the modifiable risk factors for CVD.

Keywords

Cardiovascular Disease, Modifiable Risk Factors, Non-Modifiable Risk Factors, Pacific

1. Introduction

Cardiovascular disease (CVD) is a lifestyle disease that is defined as heart and blood vessel disease, also known as heart disease, which is related to atherosclerosis [1].

Globally, according to the World Health Organization (WHO), an estimated 16.7 million people die from CVD annually. Of the total deaths, about 8.6 million are women and 4.5 million are men [2]. In Canada, an estimated 8 million deaths are caused by CVD [3]. In the United Kingdom, an estimated 245,000 deaths occur as a result of CVD [4]. The burden of CVD is not only affecting developed countries, instead the burden is worldwide. According to WHO (2009), 16.6 million deaths attributed to CVD worldwide. 80% of deaths are in the developing countries, including Pacific regions [5]. The prevalence of CVD in the Pacific was 21.1% in 2011 with an increasing trend [6]. For instance, 26.2% of Samoan diabetic adults had CVD [7].

Some of the identified risk factors of CVD in the world are; high blood pressure, rapid acculturation and improvement in economic conditions, economical transition, increased tobacco use, high blood lipids, physical inactivity, over-weight and obese, diabetes and poor nutrition [8] [9]. In the Asia-Pacific regions there was also some research done to identify some of the major risk factors for CVD. For instance, Asian Pacific Countries Society (APCS) identified obesity, diabetes, dyslipidemia and hypertension as risk factors for CVD in the Asia-Pacific regions [10]. Furthermore, according to [11], the study identified five other risk factors which are chiefly; socio-demographic, economical transition, elevated blood pressure, cigarette smoking, lipids and excess body weight. It has also been found that different ethnic groups have their own risk behaviors for CVD [12] [13].

Based on the literature review, there was no systematic review study in the Pacific identifying the risk factors or determinants of CVD. Therefore, the main purpose of this systematic review is to identify the determinants of CVD existing in the Pacific region as a platform for the Pacific Island Countries (PIC) to develop their own health promotion and prevention strategies on how to tackle the identified risks in the future. On the other hand, as we know CVD has a greater impact to the developing nation hence, to reduce the burden from happening we have to identify the risk as possible in-order to find solution on how to promote and prevent people life.

2. Methodology

This was a systematic review which was conducted using different databases including Scopus, Medline, EMBASE, psycINFO. The present review was based on the Cochrane review process. These databases were used based on their availability and also their

frequency of use in similar previous systematic review studies. All articles published in the English language between 1 January 2000 and 1 September 2016, using quantitative and qualitative research, were included in the search. Review articles, news articles and conference abstracts were excluded. Key words used to search in selected databases included “Pacific” AND “Cardiovascular” OR “cardiac” OR “heart disease” AND “risk factors”. The systematic review of the studies was conducted in three stages. In the first stage, the titles of all searched studies were screened and those not relevant were omitted. In the second stage, the abstract of the remaining articles were reviewed and those not relevant or if they didn’t have a clear methodology were omitted. In the third stage, the full text of the remaining articles was reviewed and some of them omitted (**Figure 1**).

Finally, 31 articles were included in the review. The bibliography of those articles were reviewed and 14 articles were added so 45 studies were considered for the final study. All relevant information was extracted and included in the data extraction sheet. The data extraction sheet was in four parts including the study, participants, methodology, and results (**Appendix 1** and **Appendix 2**). A descriptive analysis was conducted using frequency and percentage to measure the common risk factors of CVD in Pacific countries.

3. Results

The pooled number of people in 45 studies was 10,376,734. The result of the study shows that eight studies focused on older people aged 50 years old and over. Three studies focused on children and adolescents aged less than 20 years old. The rest of the thirty studies (66.7%) were conducted among adults aged 20 to 49 years old. Ages of the participants in four of the studies were not reported.

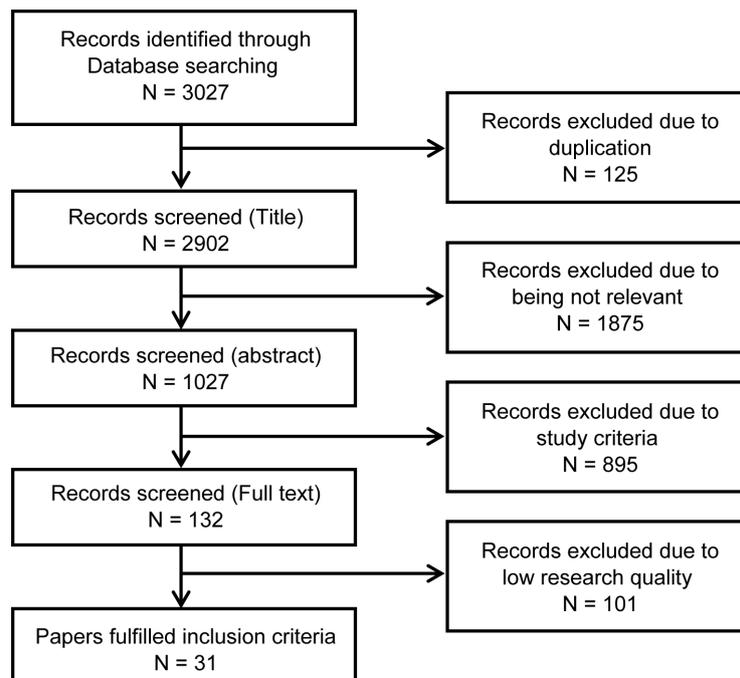


Figure 1. Article selection process.

The results show that 38% of the studies were published from 2000 to 2005, 24% of the studies were published in the years 2006 to 2010, while the remaining 38% of the studies were published in 2011 to 2016. The majority of the studies (73%) were cohort studies while 2% of the studies were case control. The majority of the participants in the studies were from the Asia Pacific region (73%), while in 7% of the studies, participants were from United States of America. Thirty-three percent of the studies focused on both males and females, while 4.5% of the studies focused on male participants only (Table 1).

Figure 2 shows the frequency of the studies based on non-modifiable risk factors of cardiovascular disease. Age was the most frequent risk factor (11 studies) while ethnicity was the risk factor least associated with cardiovascular disease in the Pacific countries.

Figure 3 shows that diabetes and abnormal blood lipids, among the modifiable risk factors for cardiovascular disease, are more common in Pacific islanders, based on the studies. This was followed by high blood pressure, overweight and obesity and smoking, while alcohol intake, among the modifiable risk factors, is the least common.

Table 1. Characteristics of the studies (n = 45).

Factor	Frequency	Percentage
Year of the study		
2000-2005	17	38
2006-2010	11	24
2011-2016	17	38
Type of study		
Cohort	32	73
Cross-sectional	8	18
RCTs	3	7
Case-control	1	2
Countries of the study		
Asia Pacific	37	82
Pacific region	5	11
United states	3	7
Gender of participants		
Male and female	15	33.3
Male	2	4.5
Female	9	20
Unknown	19	42.2

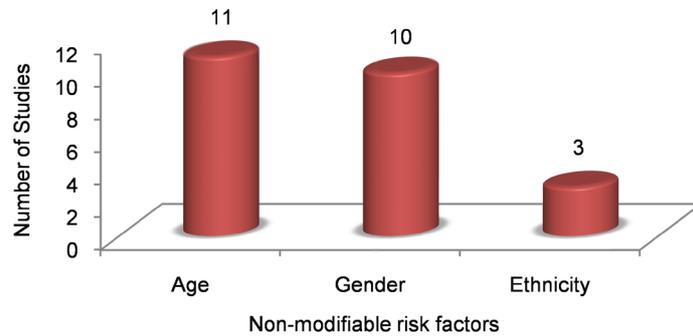


Figure 2. Frequency of studies based on Non-modifiable risk factors.

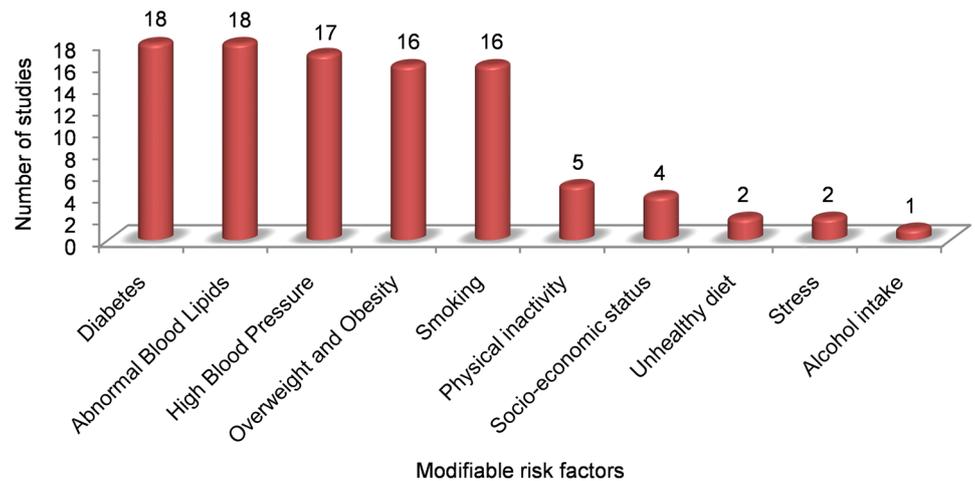


Figure 3. Frequency of studies based on modifiable risk factors.

Effectiveness of the intervention:

As the results revealed, there were three randomized controlled trials (RCTs) implemented to reduce the risk factors of cardiovascular disease. Mark *et al.* (2011) used “small-sided games and based exercise on fitness and health parameters among Pacific adults over four weeks”. The effectiveness of the intervention was greater among intervention participants than the control participants; cardiorespiratory fitness ($p = 0.003$), leg strength ($p = 0.04$) and high density lipoprotein ($p = 0.02$). The EunJoo Cho *et al.* (2013) study showed that proactive multifactorial intervention was more effective in reducing cardiovascular disease risk among the intervention group than usual care among participants from both Pacific Asia (-37.1% versus -3.5% , $p < 0.001$) and non-Pacific Asia countries (-31.1% versus -4.2% , $p < 0.001$). In addition, the EunJoo Cho *et al.* (2014) study also showed that there was a greater reduction in systolic blood pressure (-19.1 vs. -9.0 , 95% CI-8.33 - 0.52), DBP (-8.3 vs. -3.9 , 95% CI-3.83, -3.9), low density lipoprotein cholesterol (-20.5 vs. 1.2 , 95% CI-24.66, -16.97 , and total cholesterol (-28.2 vs. 3.7 , 95% CI-38.25, -24.35) in the proactive multifactorial intervention (PMI) arm compared with the usual care (UC) arm at week 52 for Pacific Asia patients.

4. Discussion

The present study highlighted the most frequent non-modifiable and modifiable risk factors of CVD in the Pacific region.

The results showed that age was the main non-modifiable risk factor of CVD among Pacific Asian countries. Most of the studies conducted among adults and older people showed that increasing age increases the chances of getting CVD [10]. CVD affects all age groups in the Pacific as a result of modernization associated with the modifiable risk factors for CVD, including diabetes, abnormal blood lipids, high blood pressure, overweight and obesity, unhealthy diets, physical inactivity, socio-economic status, and alcohol intake [14] [15]. Nowadays, in the Pacific region, all age groups, even adolescents, are more likely to develop the risk factors for CVD at an early age as a result of modernization and changes in the family structure [16]. In the past, Pacific people used to live in extended families where they shared meals together, they worked together, and their children played together outdoors. As a result of modernization, there is a change in family structure in the Pacific islands where people started to shift into nuclear families, rather than extended [17].

Pacific islanders now grow up in a modern world where they are being exposed to unhealthy foods through media or advertisement, which result in being the first food choices [18]. Physical inactivity and unhealthy diets are risk factors for CVD and this shows that Pacific islanders are more likely to have CVD if they don't adopt a healthy lifestyle [19]. In the Pacific islands, culture plays an important role on the three different ethnic groups, namely Melanesians, Polynesians, and Micronesians, way of living. Pacific island men and women suffer from CVD as a result of the modifiable risk factors such as physical inactivity, high cholesterol, high blood pressure, and smoking, to name a few of them for both genders.

According to the ACPS; "17,050 deaths accounted for Asians and Pacific Islanders due to CVD in 2011, 31.5% in men and 32.4% in female [20]". Numerous lifestyle-related factors can cause the difference in the death rates in CVD among men and women in the Pacific. For example, in a Polynesian island country such as Tonga, women's responsibilities involve house chores, taking care of the children, and many others which stood as barriers for women to engage in physical activity [21]. In Melanesian island countries like Vanuatu and Fiji, dress code is one of the barriers that prevent women from engaging in any sort of physical activity. Similar to Tonga and Vanuatu, Micronesian women have the same barriers that prevent them from engaging in any sort of physical activity [22]. Ethnicity is another non-modifiable risk factor for CVD. According to the British heart foundation, these different ethnic groups have their own culture and traditions that they are engaged in [23].

As a result of these cultural and traditional differences, there are some things that restrict them from doing physical activity, which is a risk factor for CVD. In the Pacific, women who have limited transport options may be unable to travel to physical activity facilities because of the cultural barriers [24]. Another example is that some cultural expectations may restrict the involvement of women in certain forms of physical activ-

ity, which increases their likelihood of becoming obese, another risk factor for developing non-communicable diseases, including CVD [25] [26]. Nowadays, different ethnic groups are adopting similar behaviours, especially the engagement in the risk behaviours of CVD, like inactive physical activities, smoking, hypertension and obesity. This was shown by a study done in the Asia Pacific based on two different ethnic groups, namely Asian and Non-Asian peoples [27]. The results of the study shows that most traditional cardiovascular risk factors, including high blood pressure, obesity, and cigarette smoking, is highly associated to heart diseases in both ethnic groups, despite the differences in ethnicity status [28].

According to the results of this study, there were ten identified modifiable risk factors for CVD in the Pacific and diabetes is ranked the highest, followed by abnormal blood lipid, high blood pressure, overweight, smoking and the list continues until the least on the graph, which is alcohol intake [29]. Nevertheless, despite the hierarchy of the identified risk factors, they are all inter-related. For instance, those exposed to an unhealthy diet like high sugary and salty foods, will eventually developed diabetes or hypertension, which is a risk for CVD [30]. On the other hand, those with low socioeconomic status cannot afford to buy healthy food so they buy the cheap, unhealthy diet foods that will increase their chances of becoming overweight, resulting in high lipid deposition in the adipose tissue, which will eventually increase the chances of developing hypertension and diabetes that can later lead to CVD [31].

In conclusion, CVD is caused by both modifiable and non-modifiable predisposing risk factors and can be prevented mainly through health promoting life-style interventions. People need to know how to manage and monitor these risk factors. It is necessary to increase awareness among health care providers and systems serving Pacific islanders, at childhood stage, in suggesting accurate information, early screening and treatment, and recommend appropriate behavioural modifications for decreasing the prevalence of cardiovascular disease.

The Cochrane review process was used to develop the search strategy, appraise the articles, and analyze the data. However, in this study two reviewers independently extracted data from different types of studies and all discrepancies were agreed to by discussion with a third reviewer. This study had some limitations associated with the quality of the reviewed articles and also the approach. However, the quality of studies assessed did not show an assessment of bias that may have characterized the identified studies. Majority of studies included in this review were descriptive so there are potential biases that may affect the results of this study, such as: self-selected samples, poor description of participants, and non-validated data collection instruments.

References

- [1] Santulli, G. (2013) Epidemiology of Cardiovascular Disease in the 21st Century: Updated Numbers and Updated Facts. *Journal of Cardiovascular Disease*, **1**, 1-2.
- [2] Lloyd-Jones, D., Adams, R.J., Brown, T.M., Carnethon, M., Dai, S., De Simone, G., *et al.* (2010) Heart Disease and Stroke Statistics—2010 Update a Report from the American Heart Association. *Circulation*, **121**, e46-e215.

- <https://doi.org/10.1161/CIRCULATIONAHA.109.192667>
- [3] Allender, S., Peto, V., Scarborough, P., Boxer, A. and Rayner, M. (2007) Coronary Heart Disease Statistics.
- [4] Lloyd-Jones, D., Adams, R., Carnethon, M., De Simone, G., Ferguson, T.B., Flegal, K., *et al.* (2009) Heart Disease and Stroke Statistics—2009 Update a Report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation*, **119**, e21-e181. <https://doi.org/10.1161/CIRCULATIONAHA.108.191261>
- [5] WHO (2009) World Health Statistics 2009: World Health Organization. Geneva.
- [6] Celermajer, D.S., Chow, C.K., Marijon, E., Anstey, N.M. and Woo, K.S. (2012) Cardiovascular Disease in the Developing World: Prevalences, Patterns, and the Potential of Early Disease Detection. *Journal of the American College of Cardiology*, **60**, 1207-1216. <https://doi.org/10.1016/j.jacc.2012.03.074>
- [7] Sundborn, G.B.M. (2009) Cardiovascular Disease Risk Factors and Diabetes in Pacific Adults: The Diabetes Heart and Health Study (DHAH), Auckland, New Zealand 2002/03. The University of Auckland, Auckland. <https://researchspace.auckland.ac.nz/docs/uoa-docs/rights.htm>
- [8] Hyun, K.K., Huxley, R.R., Arima, H., Woo, J., Lam, T.H., Ueshima, H., *et al.* (2013) A Comparative Analysis of Risk Factors and Stroke Risk for Asian and Non-Asian Men: The Asia Pacific Cohort Studies Collaboration. *International Journal of Stroke*, **8**, 606-611. <https://doi.org/10.1111/ijis.12166>
- [9] Lin, W.-Y., Lee, L.-T., Chen, C.-Y., Lo, H., Hsia, H.-H., Liu, I.-L., *et al.* (2002) Optimal Cut-Off Values for Obesity: Using Simple Anthropometric Indices to Predict Cardiovascular Risk Factors in Taiwan. *International Journal of Obesity & Related Metabolic Disorders*, **26**, 1232-1238. <https://doi.org/10.1038/sj.ijo.0802040>
- [10] Asia Pacific Cohort Studies Collaboration (2004) Body Mass Index and Cardiovascular Disease in the Asia-Pacific Region: An Overview of 33 Cohorts Involving 310,000 Participants. *International Journal of Epidemiology*, **33**, 751-758. <https://doi.org/10.1093/ije/dyh163>
- [11] Woodward, M., Barzi, F., Feigin, V., Gu, D., Huxley, R., Nakamura, K., *et al.* (2007) Associations between High-Density Lipoprotein Cholesterol and Both Stroke and Coronary Heart Disease in the Asia Pacific Region. *European Heart Journal*, **28**, 2653-2660. <https://doi.org/10.1093/eurheartj/ehm427>
- [12] Holvoet, P., *et al.* (2007) The Relationship between Oxidized LDL and Other Cardiovascular Risk Factors and Subclinical CVD in Different Ethnic Groups: The Multi-Ethnic Study of Atherosclerosis (MESA). *Atherosclerosis*, **194**, 245-252. <https://doi.org/10.1016/j.atherosclerosis.2006.08.002>
- [13] Chan, W.C., Wright, C., Riddell, T., Wells, S., Kerr, A.J., Gala, G., *et al.* (2008) Ethnic and Socioeconomic Disparities in the Prevalence of Cardiovascular Disease in New Zealand. *The New Zealand Medical Journal (Online)*, **121**, 11-20.
- [14] Asia Pacific Cohort Studies Collaboration (2003) The Effects of Diabetes on the Risks of Major Cardiovascular Diseases and Death in the Asia-Pacific Region. *Diabetes Care*, **26**, 360-366. <https://doi.org/10.2337/diacare.26.2.360>
- [15] Asia Pacific Cohort Studies Collaboration (2004) Serum Triglycerides as a Risk Factor for Cardiovascular Diseases in the Asia-Pacific Region. *Circulation*, **110**, 2678-2686. <https://doi.org/10.1161/01.CIR.0000145615.33955.83>
- [16] Woodward, M., Peters, S.A., Batty, G.D., Ueshima, H., Woo, J., Giles, G.G., *et al.* (2015) Socioeconomic Status in Relation to Cardiovascular Disease and Cause-Specific Mortality: A

- Comparison of Asian and Australasian Populations in a Pooled Analysis. *BMJ Open*, **5**, e006408. <https://doi.org/10.1136/bmjopen-2014-006408>
- [17] Khor, G.L. (2001) Cardiovascular Epidemiology in the Asia-Pacific Region. *Asia Pacific Journal of Clinical Nutrition*, **10**, 76-80. <https://doi.org/10.1046/j.1440-6047.2001.00230.x>
- [18] Spreadbury, I. and Samis, A.J. (2013) Evolutionary Aspects of Obesity, Insulin Resistance, and Cardiovascular Risk. *Current Cardiovascular Risk Reports*, **7**, 136-146. <https://doi.org/10.1007/s12170-013-0293-1>
- [19] Jørgensen, T., Capewell, S., Prescott, E., Allender, S., Sans, S., Zdrojewski, T., *et al.* (2013) Population-Level Changes to Promote Cardiovascular Health. *European Journal of Preventive Cardiology*, **20**, 409-421. <https://doi.org/10.1177/2047487312441726>
- [20] Asia Pacific Cohort Studies Collaboration (2007) The Burden of Overweight and Obesity in the Asia-Pacific Region. *Obesity Reviews*, **8**, 191-196. <https://doi.org/10.1111/j.1467-789X.2006.00292.x>
- [21] Juarbe, T., Turok, X.P. and Pérez-Stable, E.J. (2002) Perceived Benefits and Barriers to Physical Activity among Older Latina Women. *Western Journal of Nursing Research*, **24**, 868-886. <https://doi.org/10.1177/019394502237699>
- [22] Huxley, R., Barzi, F. and Woodward, M. (2006) Excess Risk of Fatal Coronary Heart Disease Associated with Diabetes in Men and Women: Meta-Analysis of 37 Prospective Cohort Studies. *BMJ*, **332**, 73-78. <https://doi.org/10.1136/bmj.38678.389583.7C>
- [23] Murphy, C., *et al.* (2007) Vascular Dysfunction and Reduced Circulating Endothelial Progenitor Cells in Young Healthy UK South Asian Men. *Arteriosclerosis, Thrombosis, and Vascular Biology*, **27**, 936-942. <https://doi.org/10.1161/01.ATV.0000258788.11372.d0>
- [24] Bauman, A.E., Reis, R.S., Sallis, J.F., Wells, J.C., Loos, R.J., Martin, B.W., *et al.* (2012) Correlates of Physical Activity: Why Are Some People Physically Active and Others Not? *The Lancet*, **380**, 258-271. [https://doi.org/10.1016/S0140-6736\(12\)60735-1](https://doi.org/10.1016/S0140-6736(12)60735-1)
- [25] Hoebeke, R. (2008) Low-Income Women's Perceived Barriers to Physical Activity: Focus Group Results. *Applied Nursing Research*, **21**, 60-65. <https://doi.org/10.1016/j.apnr.2006.06.002>
- [26] Mansfield, E.D. and Pollins, B.M. (2009) Economic Interdependence and International Conflict: New Perspectives on an Enduring Debate. University of Michigan Press, Ann Arbor.
- [27] Asia Pacific Cohort Studies Collaboration (2005) A Comparison of the Associations between Risk Factors and Cardiovascular Disease in Asia and Australasia. *European Journal of Cardiovascular Prevention & Rehabilitation*, **12**, 484-491. <https://doi.org/10.1097/01.hjr.0000170264.84820.8e>
- [28] American Diabetes Association (2004) Blood Glucose and Risk of Cardiovascular Disease in the Asia Pacific Region. *Diabetes Care*, **27**, 2836-2842. <https://doi.org/10.2337/diacare.27.12.2836>
- [29] Cassels, S. (2006) Overweight in the Pacific: Links between Foreign Dependence, Global Food Trade, and Obesity in the Federated States of Micronesia. *Globalization and Health*, **2**, 10. <https://doi.org/10.1186/1744-8603-2-10>
- [30] Martiniuk, A.L., Lee, C.M., Lawes, C.M., Ueshima, H., Suh, I., Lam, T.H., *et al.* (2007) Hypertension: Its Prevalence and Population-Attributable Fraction for Mortality from Cardiovascular Disease in the Asia-Pacific Region. *Journal of Hypertension*, **25**, 73-79. <https://doi.org/10.1097/HJH.0b013e328010775f>
- [31] Bassuk, S.S. and Manson, J.E. (2005) Epidemiological Evidence for the Role of Physical Activity in Reducing Risk of Type 2 Diabetes and Cardiovascular Disease. *Journal of Applied*

- Physiology*, **99**, 1193-204. <https://doi.org/10.1152/jappphysiol.00160.2005>
- [32] Grey, C., Wells, S., Riddell, T., Kerr, A., Gentles, D., Pylpchuk, R., *et al.* (2010) A Comparative Analysis of the Cardiovascular Disease Risk Factor Profiles of Pacific Peoples and Europeans Living in New Zealand Assessed in Routine Primary Care: PREDICT CVD-11. *The New Zealand Medical Journal*, **123**, 62-75.
- [33] Huxley, R.R., Barzi, F., Woo, J., Giles, G., Lam, T.H., Rahimi, K., *et al.* (2014) A Comparison of Risk Factors for Mortality from Heart Failure in Asian and Non-Asian Populations: An Overview of Individual Participant Data from 32 prospective Cohorts from the Asia-Pacific Region. *BMC Cardiovascular Disorders*, **14**, 61. <https://doi.org/10.1186/1471-2261-14-61>
- [34] Rana, J.S., Tabada, G.H., Solomon, M.D., Lo, J.C., Jaffe, M.G., Sung, S.H., *et al.* (2016) Accuracy of the Atherosclerotic Cardiovascular Risk Equation in a Large Contemporary, Multiethnic Population. *Journal of the American College of Cardiology*, **67**, 2118-2130. <https://doi.org/10.1016/j.jacc.2016.02.055>
- [35] Lee, C.M.Y., Barzi, F., Woodward, M., Batty, G.D., Giles, G.G., Wong, J.W., *et al.* (2009) Adult Height and the Risks of Cardiovascular Disease and Major Causes of Death in the Asia-Pacific Region: 21 000 Deaths in 510 000 Men and Women. *International Journal of Epidemiology*, **38**, 1060-1071. <https://doi.org/10.1093/ije/dyp150>
- [36] Hosey, G., Samo, M., Gregg, E., Barker, L., Padden, D. and Bibb, S. (2014) Association of Socioeconomic Position and Demographic Characteristics with Cardiovascular Disease Risk Factors and Healthcare Access among Adults Living in Pohnpei, Federated States of Micronesia. *International Journal of Chronic Diseases*, **2014**, Article ID: 595678. <https://doi.org/10.1155/2014/595678>
- [37] Association, A.D. (2004) Blood Glucose and Risk of Cardiovascular Disease in the Asia Pacific Region. *Diabetes Care*, **27**, 2836-2842. <https://doi.org/10.2337/diacare.27.12.2836>
- [38] Asia Pacific Cohort Studies Collaboration (2003) Blood Pressure and Cardiovascular Disease in the Asia Pacific Region. *Journal of Hypertension*, **21**, 707-716. <https://doi.org/10.1097/00004872-200304000-00013>
- [39] Asia Pacific Cohort Studies Collaboration (2003) Blood Pressure Indices and Cardiovascular Disease in the Asia Pacific Region a Pooled Analysis. *Hypertension*, **42**, 69-75. <https://doi.org/10.1161/01.HYP.0000075083.04415.4B>
- [40] Chansavang, Y., Elley, C.R., McCaffrey, B., Davidson, C., Dewes, O. and Dalleck, L. (2015) Feasibility of an After-School Group-Based Exercise and Lifestyle Programme to Improve Cardiorespiratory Fitness and Health in Less-Active Pacific and Maori Adolescents. *Journal of Primary Health Care*, **7**, 57-64.
- [41] Schaaf, D., Scragg, R. and Metcalf, P. (2000) Cardiovascular Risk Factors Levels of Pacific People in a New Zealand Multicultural Workforce. *New Zealand Medical Journal*, **113**, 3-5.
- [42] Witter, T., Poudevigne, M., Lambrick, D.M., Faulkner, J., Lucero, A.A., Page, R., *et al.* (2015) A Conceptual Framework for Managing Modifiable Risk Factors for Cardiovascular Diseases in Fiji. *Perspectives in Public Health*, **135**, 75-84. <https://doi.org/10.1177/1757913913500045>
- [43] Asia Pacific Cohort Studies Collaborations (2006) Central Obesity and Risk of Cardiovascular Disease in the Asia Pacific Region. *Asia Pacific Journal of Clinical Nutrition*, **15**, 287-292.
- [44] Nakamura, K., Barzi, F., Lam, T.-H., Huxley, R., Feigin, V.L., Ueshima, H., *et al.* (2008) Cigarette Smoking, Systolic Blood Pressure, and Cardiovascular Diseases in the Asia-Pacific Region. *Stroke*, **39**, 1694-1702. <https://doi.org/10.1161/STROKEAHA.107.496752>

- [45] Asia Pacific Cohort Studies Collaboration (2007) Cholesterol, Diabetes and Major Cardiovascular Diseases in the Asia-Pacific Region. *Diabetologia*, **50**, 2289-2297. <https://doi.org/10.1007/s00125-007-0801-2>
- [46] Asia Pacific Cohort Studies Collaboration (2003) Cholesterol, Coronary Heart Disease, and Stroke in the Asia Pacific Region. *International Journal of Epidemiology*, **32**, 563-572. <https://doi.org/10.1093/ije/dyg106>
- [47] Sundborn, G., Metcalf, P., Gentles, D., Scragg, R., Schaaf, D., Dyal, L., *et al.* (2008) Ethnic Differences in Cardiovascular Disease Risk Factors and Diabetes Status for Pacific Ethnic Groups and Europeans in the Diabetes Heart and Health Survey (DHAH) 2002-2003, Auckland New Zealand. *The New Zealand Medical Journal*, **121**, 28-39.
- [48] Tsukinoki, R., Murakami, Y., Huxley, R., Ohkubo, T., Fang, X., Suh, I., *et al.* (2012) Does Body Mass Index Impact on the Relationship between Systolic Blood Pressure and Cardiovascular Disease? Meta-Analysis of 419 488 Individuals from the Asia Pacific Cohort Studies Collaboration. *Stroke*, **43**, 1478-1483. <https://doi.org/10.1161/STROKEAHA.112.650317>
- [49] Asia Pacific Cohort Studies Collaboration (2005) Does Sex Matter in the Associations between Classic Risk Factors and Fatal Coronary Heart Disease in Populations from the Asia-Pacific Region? *Journal of Women's Health*, **14**, 820-828. <https://doi.org/10.1089/jwh.2005.14.820>
- [50] Arima, H., Murakami, Y., Lam, T.H., Kim, H.C., Ueshima, H., Woo, J., *et al.* (2012) Effects of Prehypertension and Hypertension Subtype on Cardiovascular Disease in the Asia-Pacific Region. *Hypertension*, **59**, 1118-1123. <https://doi.org/10.1161/HYPERTENSIONAHA.111.187252>
- [51] Dobson, J., Steer, A.C., Colquhoun, S. and Kado, J. (2012) Environmental Factors and Rheumatic Heart Disease in Fiji. *Pediatric Cardiology*, **33**, 332-336. <https://doi.org/10.1007/s00246-011-0139-x>
- [52] Gu, Y., Warren, J., Walker, N. and Kennelly, J. (2013) Gender Differences in Cardiovascular Disease Risk Management for Pacific Islanders in Primary Care. *Quality in Primary Care*, **21**, 275-285.
- [53] Huxley, R.R., Barzi, F., Lam, T.H., Czernichow, S., Fang, X., Welborn, T., *et al.* (2011) Isolated Low Levels of High-Density Lipoprotein Cholesterol Are Associated with an Increased Risk of Coronary Heart Disease an Individual Participant Data Meta-Analysis of 23 Studies in the Asia-Pacific Region. *Circulation*, **124**, 2056-2064. <https://doi.org/10.1161/CIRCULATIONAHA.111.028373>
- [54] Asia Pacific Cohort Studies Collaboration (2005) Joint Effects of Systolic Blood Pressure and Serum Cholesterol on Cardiovascular Disease in the Asia Pacific Region. *Circulation*, **112**, 3384-3390. <https://doi.org/10.1161/CIRCULATIONAHA.105.537472>
- [55] Howard, B.V., Criqui, M.H., Curb, J.D., Rodabough, R., Safford, M.M., Santoro, N., *et al.* (2003) Risk Factor Clustering in the Insulin Resistance Syndrome and Its Relationship to Cardiovascular Disease in Postmenopausal White, Black, Hispanic, and Asian/Pacific Islander Women. *Metabolism*, **52**, 362-371. <https://doi.org/10.1053/meta.2003.50057>
- [56] Roy, S.S., Foraker, R.E., Girton, R.A. and Mansfield, A.J. (2015) Posttraumatic Stress Disorder and Incident Heart Failure among A Community-Based Sample of US Veterans. *American Journal of Public Health*, **105**, 757-763. <https://doi.org/10.2105/AJPH.2014.302342>
- [57] Feigin, V., Parag, V., Lawes, C.M., Rodgers, A., Suh, I., Woodward, M., *et al.* (2005) Smoking and Elevated Blood Pressure Are the Most Important Risk Factors for Subarachnoid Hemorrhage in the Asia-Pacific Region: An Overview of 26 Cohorts Involving 306 620 Par-

- participants. *Stroke*, **36**, 1360-1365. <https://doi.org/10.1161/01.STR.0000170710.95689.41>
- [58] Kengne, A.P., Nakamura, K., Barzi, F., Lam, T.H., Huxley, R., Gu, D., *et al.* (2009) Smoking, Diabetes and Cardiovascular Diseases in Men in the Asia Pacific Region. *Journal of Diabetes*, **1**, 173-181. <https://doi.org/10.1111/j.1753-0407.2009.00028.x>
- [59] Asia Pacific Cohort Studies Collaboration (2005) Smoking, Quitting, and the Risk of Cardiovascular Disease among Women and Men in the Asia-Pacific Region. *International Journal of Epidemiology*, **34**, 1036-1045. <https://doi.org/10.1093/ije/dyi104>
- [60] Hosey, G.M., Samo, M., Gregg, E.W., Padden, D. and Bibb, S.G. (2014) Socioeconomic and Demographic Predictors of Selected Cardiovascular Risk Factors among Adults Living in Pohnpei, Federated States of Micronesia. *BMC Public Health*, **14**, 895. <https://doi.org/10.1186/1471-2458-14-895>
- [61] Cho, E.J., Kim, J.H., Sutradhar, S., Yunis, C., Westergaard, M. and Investigators, C.T. (2013) Proactive Multifactorial Intervention Strategy Reduces the Risk of Cardiovascular Disease Estimated with Region-Specific Risk Assessment Models in Pacific Asian Patients Participating in the CRUCIAL Trial. *Journal of Korean medical science*, **28**, 1741-1748. <https://doi.org/10.3346/jkms.2013.28.12.1741>
- [62] Biddle, M., Vincent, G., McCambridge, A., Britton, G., Dewes, O., Elley, C.R., *et al.* (2011) Randomised Controlled Trial of Informal Team Sports for Cardiorespiratory Fitness and Health Benefit in Pacific Adults. *Journal of Primary Health Care*, **3**, 269-277.
- [63] Cho, E.J., Kim, J.H., Sutradhar, S., Yunis, C. and Westergaard, M. (2014) Reduction in Cardiovascular Risk Using a Proactive Multifactorial Intervention Is Consistent among Patients Residing in Pacific Asian and Non-Pacific Asian Regions: A CRUCIAL Trial Subanalysis. *Vascular Health and Risk Management*, **10**, 145-156. <https://doi.org/10.2147/VHRM.S54586>

Abbreviations

Cardiovascular disease (CVD), Non-communicable diseases (NCDs), Pacific Island Countries (PIC), Randomized controlled trials (RCTs).

Appendix 1. Descriptive Studies

N	Study	Population	Results
1	Hyun <i>et al.</i> , [8] Year: 2013 Type: Cohort study Country: Asia Pacific	Number: 386,411 Male: 386,411 Age: (Mean) 52 years	1) Systolic blood pressure 2) Cholesterol 3) BMI 4) Diabetes 5) Cigarette smoking
2	Grey <i>et al.</i> , [32] Year: 2010 Type: Cohort study Country: New Zealand	Number: 39,835 (Europeans), 10,301 Pacific peoples Age: 35 to 74 years	1) Cigarette Smoking 2) Diabetes 3) Diastolic blood pressure 4) Cholesterol
3	Huxley <i>et al.</i> , [33] Year: 2014 Type: Cohort study Country: Asia Pacific Region	Number: 543,694 Female: 36% Age: 18 and over	1) Systolic Blood pressure 2) Diabetes 3) BMI 4) Cigarette Smoking 5) Cholesterol
4	Asia Pacific Cohort Studies Collaboration, [27] Year: 2005 Type: Cohort Study Country: Asia Pacific	Number: 331,100 Female: 41% Age: 39 to 79 years old	1) Systolic blood pressure 2) Cholesterol 3) Triglycerides 4) Body Mass Index 5) Diabetes 6) Cigarette Smoking
5	Rana <i>et al.</i> , [34] Year: 2016 Type: Cohort Study Country: USA	Number: 307,591 (22,283 were black, 52,917 were Asian/Pacific Islanders, and 18,745 Hispanic) Age: between 40 to 75 years old	1) Cholesterol
6	Lee <i>et al.</i> , [35] Year: 2009 Type: Cohort study Country: Asia Pacific Region	Number: 510,800 Age: 39 to 60 years old	1) Sex
7	Hosey <i>et al.</i> , [36] Year: 2014 Type: Cross-sectional Study Country: Federated States of Micronesia	Number: 1638 Male: 612 Female: 996 Age: mean age 39.7 years	1) Socioeconomic position 2) Demographic characteristics (age, gender, and income)
8	Woodward <i>et al.</i> , [11] Year: 2007 Type: Cohort Study Country: Asia Pacific	Number: 79,649 Female: 79,649 Age: 39 - 79 years	1) Cholesterol
9	Association, [37] Year: 2004 Type: Cohort Study Country: Asia Pacific	Number: 265,464 Age: More than 20 years old	1) Diabetes

Continued

10	Asia Pacific Cohort Studies Collaboration, [38] Year: 2003 Type: Cohort Studies Country: Asia Pacific	Number: 425,325 Age: 60 - 70 years old	1) Age 2) Sex (Gender) 3) Blood Pressure
11	Asia Pacific Cohort Studies Collaboration, [39] Year: 2003 Type: Cohort Study Country: Asia Pacific	Number: 94,147 Female: 94,147 Age: mean age 54	1) Age 2) Gender 3) Systolic Blood Pressure 4) Diastolic Blood Pressure 5) Mean Arterial Pressure 6) Pulse Pressure 7) Cholesterol 8) Cigarette Smoking
12	Asia Pacific Cohort Studies Collaboration, [10] Year: 2004 Type: Cohort Study Country: Asia Pacific Region	Number: 310,283 Female: 47% Age: Mean age 47	1) Age 2) Gender 3) Body Mass Index
13	Chansavang <i>et al.</i> , [40] Year: 2015 Type: Cross Sectional Study Country: New Zealand	Number: 18 Male: 4 Female: 14 Age: mean 16.3	1) Obesity 2) Physical inactivity
14	Schaaf <i>et al.</i> , [41] Year: 2000 Type: Cross-Sectional Study Country: New Zealand	Number: 650 Male: Samoans (205), Cook Islands (105), Tongans (55), Niuean (32) Female: Samoans (152), Cook Islands (72), Tongans (16), Niuean (13) Age: 40 - 65 years	1) Diabetes 2) Cholesterol 3) Smoking 4) Physical inactivity 5) BMI
15	Witter <i>et al.</i> , [42] Year: 2015 Type: Cross-sectional study Country: Fiji	Number: 834,000 Age: 15 - 64 years	1) Physical inactivity 2) Poor nutrition 3) Excessive alcohol intake 4) Cigarette smoking 5) Obesity 6) Diabetes mellitus 7) High cholesterol 8) High blood pressure
16	Asia Pacific Cohort Studies Collaborations, [43] Year: 2006 Type: Cohort Study Country: Asia Pacific	Number: 45,988 Female: 48% Age: 54 Years	1) Age 2) Sex 3) Ethnicity 4) BMI
17	Nakamura <i>et al.</i> , [44] Year: 2007 Type: Cohort Study Country: Asia Pacific	Number: 563,144 (82% Asians) Female: 35% Age: mean age 47 years	1) Cigarette Smoking 2) Increased levels of blood pressure

Continued

18	Asia Pacific Cohort Studies Collaboration, [45] Year: 2007 Type: Cohort Study Country: Asia Pacific Region	Number: 333,533	1) Total Cholesterol 2) Diabetes
19	Asia Pacific Cohort Studies Collaboration, [46] Year: 2003 Type: Cohort Study Country: Asia Pacific Region	Number: 352,033 Female: 42% Age: 47 years	1) Cholesterol level
20	McDonald-Sundborn <i>et al.</i> , [47] Year: 2002-2003 Type: Cross-Sectional study Country: New Zealand	Number: 1011 (Samoans: 484, Tongans: 252, Niuean: 109, Cook Islands: 116) Male: 464 Female: 500 Age: 35 - 75 years	1) Ethnicity 2) Cigarette Smoking 3) Physical Inactivity 4) BMI 5) Blood Pressure 6) Cholesterol 7) Diabetes
21	Tsukinoki <i>et al.</i> , [48] Year: 2012 Type: Cohort Study Country: Asia Pacific	Number: 419,488 Age: more than 30 years old	1) Age 2) Elevated Blood Pressure 3) Excess Body Mass Index 4) Smoking
22	Asia Pacific Cohort Studies Collaboration, [49] Year: 2005 Type: Cohort study Country: Asia Pacific Region	Number: 1989 Male: 1063 Female: 926 Age: 20 years and above	1) Age 2) Sex 3) Blood Pressure 4) Total Cholesterol 5) BMI 6) Cigarette Smoking 7) Diabetes
23	Arima <i>et al.</i> , [50] Year: 2012 Type: Cohort Study Country: Asia Pacific Region	Number: 346,570 Male: 204,476.3 (59%) Female: 142,093.7 (41%) Age: mean 48 years	1) Smoking 2) Total Cholesterol
24	Arima <i>et al.</i> , [50] Year: 2008 Type: Cohort Study Country: Asia Pacific	Number: 380,483 (Adults) Age: 15 and above	1) Total Cholesterol
25	Dobson <i>et al.</i> , [51] Year: 2011 Type: Case Control Study Country: Fiji	Number: 160 Male: 80 Female: 80 Age: between 5 & 15 years	1) Genetic Factors that are influence by environmental factors (crowding and poverty)
26	Gu <i>et al.</i> , [52] Year: 2013 Type: Cohort Study Country: New Zealand	Number: 10,863 Age: 35 years (Men), 45 years (Women)	1) Gender

Continued

27	Martiniuk <i>et al.</i> , [30] Year: 2007 Type: Cohort Study Country: Asia Pacific Region	Number: 600,000 Age: adults	1) Hypertension
28	Martiniuk <i>et al.</i> , [30] Year: 2009 Type: Cohort Study Country: Asia Pacific Region	Number: 378,579 Age: 20 years and older	1) Elevated levels of Body Mass Index 2) Cigarette Smoking
29	Huxley <i>et al.</i> , [53] Year: 2011 Type: Cohort Study Country: Asia Pacific Region	Number: 220,060 Age: 37 - 54 years	1) Low levels of high density lipoprotein cholesterol
30	Asia Pacific Cohort Studies Collaboration, [54] Year: 2005 Type: Cohort Study Country: Asia Pacific Region	Number: 2,547,447	1) Systolic Blood Pressure 2) Serum Cholesterol
31	Asia Pacific Cohort Studies Collaboration, [54] Year: 2015 Type: Cohort Study Country: Pacific	Number: 396 Male: 43.9% Female: 56.1% Age: median age 18 years (Men)	1) Age 2) Sex 3) Ethnicity
32	Asia Pacific Cohort Studies Collaboration, Year: 2001 Type: Cross Sectional Study Country: Asia Pacific Region	Number: 213,515	1) Diabetes 2) Physical inactivity 3) Unhealthy Diets 4) Emotional stress
33	Howard <i>et al.</i> , [55] Year: 2003 Type: Cross-Sectional Study Country: United State of America	Number: 3083 Male: None Female: 1635 (whites), 802 (blacks), 390 (Hispanic), 256 (Asian/Pacific Islanders) Age: 50 - 79 years	1) Insulin resistance syndrome
34	Roy <i>et al.</i> , [56] Year: 2015 Type: Cohort Study Country: USA	Number: 8248 Age: 45 - 89 years	1) Age 2) Diabetes 3) Hypertension 4) Overweight 5) Obesity 6) Combat service 7) Posttraumatic Stress

Continued

35	Asia Pacific Cohort Studies Collaboration, [15] Year: 2004 Type: Asia Pacific Country: Cohort Study	Number: 96,224 Age: 48.4 years	1) Serum triglycerides
36	Feigin <i>et al.</i> , [57] Year: 2005 Type: Cohort Study Country: Asia Pacific Region	Number: 306,620 Age: Mean 48	1) Cigarette Smoking 2) Elevated Blood Pressure
37	Kengne <i>et al.</i> , [58] Year: 2009 Type: Cohort Study Country: Asia Pacific Region	Number: 205,389 Male: 205,389 Age: Men (With diabetes: 5211 years) (without diabetes: 4811 years)	1) Cigarette Smoking 2) Diabetes
38	Asia Pacific Cohort Studies Collaboration, [59] Year: 2005 Type: Cohort Study Country: Asia Pacific	Number: 463,674 Asian (33% female) and 96,664 Australasians (45% female) Male: 63% Asians and 55% Australasians Female: 33% Asians Female and 45% Australasians female Age: Australasians (mean age: 53.2 years) and Asians (mean age: 46.5 years)	1) Cigarette Smoking
39	Hosey <i>et al.</i> , [60] Year: 2014 Type: Cross-Sectional Study Country: Federated State of Micronesia	Number: 1639 Male: 642 Female: 996 Age: 25 - 64 years	1) Age 2) Sex 3) Socioeconomic position
40	Woodward <i>et al.</i> , [16] Year: 2014 Type: Cohort Study Country: Asia Pacific	Number: 303,036 (71% Asians) Male: 32% Female: 68% Age: mean: 47 years	1) Socioeconomic Status
41	Woodward <i>et al.</i>	Number: 368,307	1) Systolic Blood Pressure 2) Diabetes
42	Cho <i>et al.</i> , [61] Year: 2002 Type: Cohort Study Country: Asia Pacific	Number: 161,214 (58% Asians with diabetes) Male: 50% Female: 50% Age: 20 - 107 years	1) Age 2) Ethnicity 3) Diabetes

Appendix 2. Intervention Studies

N	Study	Population	Intervention	Results
1	Biddle <i>et al.</i> , [62] Year: 2011 Type: Randomized Controlled Trial Country: New Zealand	Number: 20 Male: 7 Female: 13 Age: 34.8 (mean) Intervention Group members: 11 Control Group members: 9	Package: Small sided games based exercise on fitness and health parameters among pacific adults How long: 1) 45 minutes for intervention participants three times per week for four weeks. 2) Control group offered one month gym membership after the trial	1) Obesity 2) Type 2 diabetes
2	Cho <i>et al.</i> , [63] Year: 2014 Type: Randomized Controlled Trial Country: Asia Pacific, Middle East, Europe, and Latin America	Number: 1417 Male: 284 (Pacific Asians: 63.4%), 445 (Non-Pacific Asians: 46.9%) Female: 164 (Pacific Asians: 36.6%), 515 (Non-Pacific Asians: 53.1%) Age: 35 - 79 years	Package: Proactive Multifactorial Intervention (PMI) strategy based on single-pill amlodipine/atorvastatin (SPAA) and usual care (UC). How Long: 12 months	1) Diabetes
3	Cho <i>et al.</i> , [61] Year: 2013 Type: Randomized Controlled Trial Country: Asia Pacific	Population: 448 Male: 284 Female: 174 Age: 35 - 79 years	Package: Proactive Multifactorial Intervention Strategy based on SPAA and UC How Long: 12 months	1) Hypertension



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