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Prevalence of non-communicable diseases and their risk factors in Papua New Guinea: A systematic review

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Abstract

Introduction: The mortality associated with non-communicable diseases has increased significantly in most countries in the World Health Organization Western Pacific Region over the last 20 years, as have the underlying risk factors. This study aimed to collate evidence on the prevalence of four major non-communicable diseases and their risk factors in Papua New Guinea in order to inform appropriate policy for their prevention and management.

Methods: We performed a systematic review of Papua New Guinea-based population prevalence studies of cardiovascular diseases, type 2 diabetes mellitus, chronic respiratory diseases, and cancers, as well as non-communicable disease risk factors published before 2016. Five online databases were searched and screened against eligibility criteria according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Results: A total of 57 articles were included in this review, most of which (n = 48) were published prior to 2000. Eleven articles reported on diabetes, six reported on chronic lung disease/asthma, two reported on cardiovascular diseases, and two reported cancer as the primary outcome, while the remaining 36 papers reported non-communicable disease risk factors.

Conclusion: This review demonstrated variations in the prevalence of non-communicable diseases (0%–19%) and their risk factors (0%–80.6%) attributed to the lifestyle and genetic diversity of the Papua New Guinea population. There is a strong suggestion that the prevalence of non-communicable diseases (particularly type 2 diabetes mellitus) and key non-communicable disease risk factors (hypertension, overweight, and obesity) has increased, but there is a lack of recent data. As such, there is an urgent need for new and up-to-date data in all areas of Papua New Guinea.

Keywords

Non-communicable disease, non-communicable disease risk factors, systematic review, Papua New Guinea, population studies

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Introduction

Non-communicable diseases (NCDs) are the leading cause of morbidity worldwide. The World Health Organization (WHO)[1] estimated that 41 million of the 57 million deaths in 2016 were due to NCDs, the majority of which (78%) occurred in low- and middle-income countries (LMICs). The prevalence of major NCDs – including cardiovascular diseases (CVDs), cancer, chronic respiratory diseases, and type 2 diabetes mellitus (T2DM) – is increasing, and they remain a challenge for both high-income countries (HICs) and LMICs.[2–4] Recently, countries in the WHO Western Pacific Region (WPR) have seen a drastic increase in NCD mortality and associated risk factors.[5] In addition to an established

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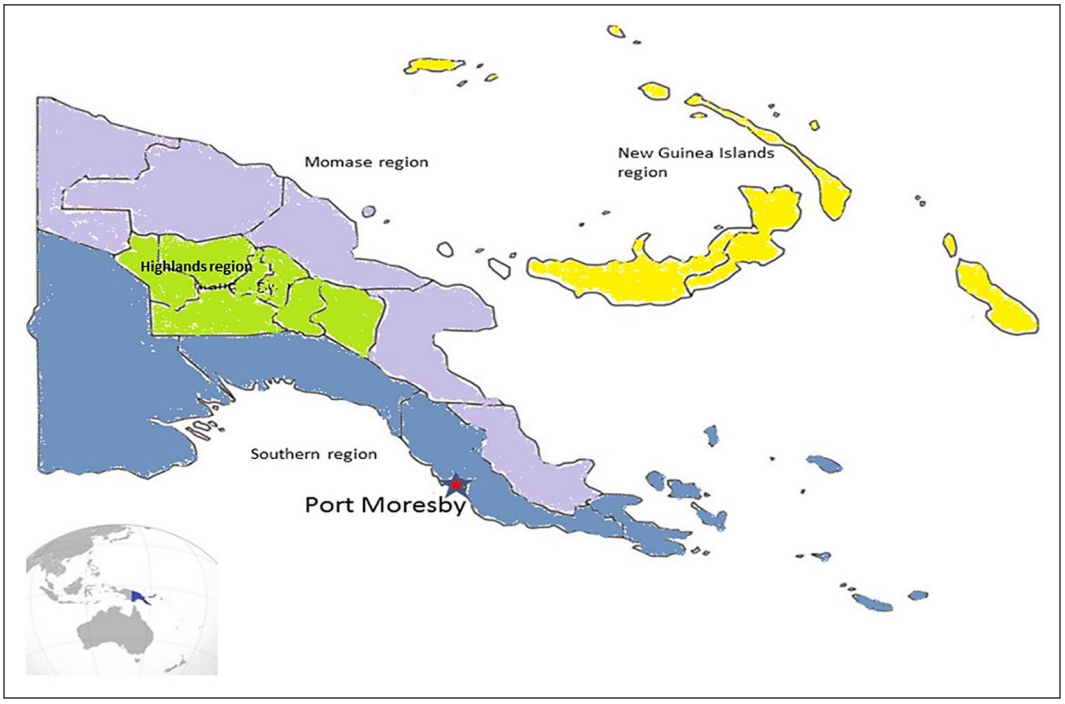

Figure 1. Map of Papua New Guinea.
★: Port Moresby, capital city.
Source: https://d-maps.com/pays.php?num_pay=286&lang=en.

infectious disease burden,[6] the increasing burden of NCDs and risk factors pose a grave risk to the future health and prosperity of these nations.[7]

Papua New Guinea (PNG) is an ethnically and linguistically diverse lower middle-income country in the WPR, with a population of 7.3 million people.[8] The country has four geographical regions: (1) Southern region (SR), (2) Momase region (MR), (3) Highland region (HR), and (4) New Guinea Islands (NGI) region (Figure 1). PNG has experienced a resource boom over the last decade, which has led to increased development[9] and socio-economic transition.

The PNG WHO statistical profile reported an increase in the number of deaths caused by CVDs and T2DM between 2000 and 2012.[10] The limited available evidence in PNG suggests a rise in NCDs in recent years, particularly with respect to T2DM and CVD. Furthermore, the death estimates in the country, as shown by the Global Burden of Disease studies, showed that NCD-related deaths – particularly ischaemic heart disease, stroke, chronic obstructive pulmonary disease (COPD), and T2DM – increased considerably between 2007 and 2017.[11] However, prevalence data are only available for specific populations, and broader trends across the entire population remain unexplored. For example, T2DM and pre-diabetes are thought to be especially prevalent among the Austronesian language–speaking group, comprised of people living in coastal and offshore islands of NGI, who are known to carry the thrifty gene;[12–14] however, it is unclear whether T2DM and its associated risk factors are increasing in other ethnic groups. Available hospital-based data indicate that coronary artery disease was a rare cause of hospital admission in PNG prior to the 1960s.[15] Indeed, a review of 2000 hospital admissions to the medical ward of Port Moresby General Hospital, PNG's biggest referral hospital, in the 1960s did not reveal a single case of coronary heart disease.[16] A cancer registry was established in Port Moresby in 1958 to register cancer cases across PNG, and reviews based on these data indicated a small increase in the incidence of cancer between 1958 and 1988.[17,18] However, it is unknown whether the registry still exists, is regularly updated, or whether any further review has been performed. Available but limited data on chronic respiratory diseases also indicate that chronic lung disease (CLD) is prevalent in both the highland and coastal areas of the country.[19] However, it is unknown whether there has been any increase or decrease in the prevalence in the general population.

Although some small studies have found relevant evidence from particular communities, to date, there has been no attempt to perform a systematic and comprehensive review of all available NCD data. Available prevalence data from PNG are limited and inconsistent, and thus needs to be synthesised. Therefore, this study aimed to collate evidence on the prevalence of four major NCDs, namely, CVD, T2DM, chronic respiratory diseases, and cancers, and their associated risk factors, in order to establish the extent of available evidence. Findings from this study can be used to inform policy concerning the prevention and control of NCDs in PNG.

Methods

Based on the protocol (Supplemental Appendix 1), a systematic review was undertaken of PNG-based, general population prevalence studies for selected NCDs (coronary heart diseases and stroke, T2DM, CLD/COPD/asthma, and cancers of the breast, lungs, stomach, liver, and oral), and their risk factors published before 2015.

Search strategy

The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[20] An initial (September 2015) and updated (July 2016) electronic search was undertaken using the following five databases: PubMed, MEDLINE, Scopus, Web of Science, Centre for Agriculture and Biosciences (CAB) abstracts, and Global Health. The following key terms were employed: 'Papua New Guinea' AND 'non-communicable disease' OR cardiovascular disease. A full list of the key search terms is available in the appendix (Supplemental Appendix 2). Additional articles were sought by a manual review of the listed references in the retrieved articles.

Inclusion/exclusion criteria

This review was limited to published peer-reviewed papers in English. For an article to be included, the following criteria had to be met in accordance with the PICOS (population, intervention, comparator, outcome, and study design) principle in the Cochrane Handbook:[21]

1. Participants: general Papua New Guinean adult population (15+ years).
2. Outcomes: prevalence data relating to one or more of the following NCDs:
   (a) T2DM.
   (b) CVDs, particularly coronary heart disease and stroke.
   (c) COPD and asthma.
   (d) Cancers of the mouth, lungs, liver, stomach, and breast.
3. And/or prevalence data of associated risk factors limited to:
   (a) Hypertension.
   (b) Elevated lipids.
   (c) Overweight and obesity.
   (d) Lack of physical activity.
   (e) Tobacco smoking.
   (f) Harmful use of alcohol.
4. Study design: population-based studies that presented the prevalence of NCDs and their risk factors.

Articles were excluded if:

5. They did not meet the inclusion criteria.
6. The full-text article was not available.
7. The sample size was less than 100.

Data extraction and study selection

As shown in Figure 2, a total of 5039 records were imported into EndNote X7 (EndNote™); from this, 4117 duplicates were removed, and the remaining 922 article titles and abstracts were independently screened by two authors, P.R. and S.G. Based on the abstract and title review, 719 studies were excluded. The full texts of the remaining 203 studies were separately reviewed by P.R. and S.G. using the inclusion and exclusion criteria, with discrepancies resolved by consensus opinion. A total of 154 articles were excluded following full-text review, leaving 49 relevant articles. A manual search of the references listed in these included articles yielded another eight articles which met the inclusion criteria. The data reported in 57 articles were independently extracted by P.R., S.G., and S.N.B., with discrepancies resolved by consensus opinion.

Data extracted from these articles were based on the Cochrane Handbook for Systematic Reviews,[21] and included author(s), study aim(s), methodology, population surveyed, and the primary outcome or prevalence data.

Quality assessment of the included studies

The quality of the included studies was reviewed by P.R., S.G., and S.N.B, using an adapted version of the Joanna Briggs Institute (JBI) Critical Appraisal tools for Systematic Reviews;[22] the adapted version of the appraisal tool is a merged checklist for prevalence and cross-sectional studies (see Supplemental Appendix 3). Using the JBI checklist, P.R., S.G., and S.N.B. independently appraised each article and tabulated the combined quality assessment, any disagreement was resolved through discussion. The checklist focused on 12 areas, which each published study was measured against; this included the use of an appropriate sampling frame, appropriate sampling of participants, adequate sample size, description of the study setting and subjects, eligibility criteria clearly defined, valid and reliable measure of exposure, valid methods used to define conditions, data analysis, appropriate statistical analysis used, identifying and dealing with confounding factors, and adequate response rates.

Data synthesis

A narrative synthesis was conducted by P.R. under the four major disease headings of T2DM, CLD, CVD, cancer, and

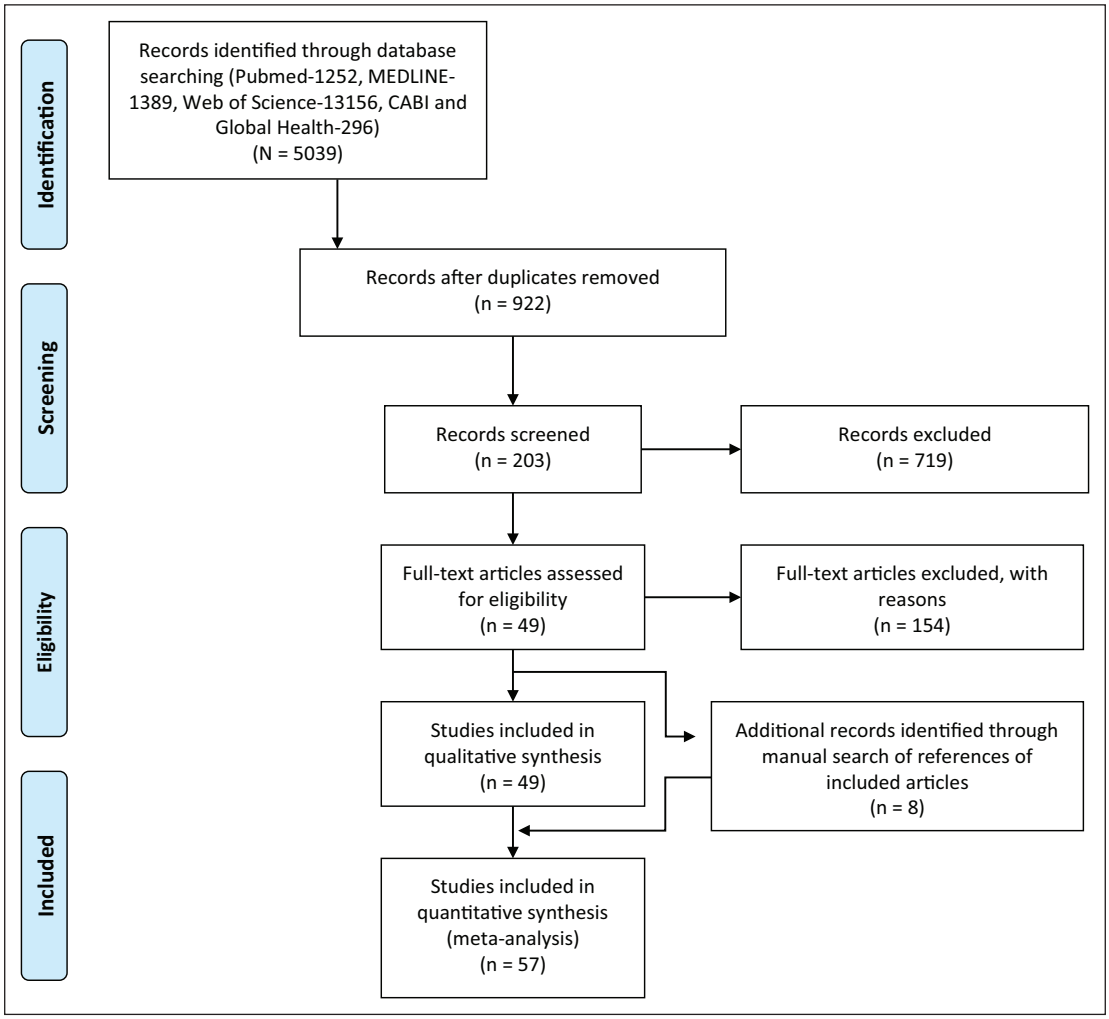

Figure 2. Flow diagram showing the articles screened and considered for inclusion in this review.

risk factors. It was not possible to calculate the pooled prevalence of the diseases and risk factors due to the high variability among the studies.

Results

Description of the included studies

A total of 57 articles fulfilled the inclusion criteria. Eleven articles[23–33] reported on T2DM as the primary outcome, six articles reported on CLD/asthma,[34–39] two articles reported on CVDs,[40,41] and two reported on cancer[42,43] (Supplemental Table S1). The remaining 36 articles reported the prevalence of NCD risk factors as the primary outcome, including hypertension (n=9),[44–52] lipids (n=6),[53–58] overweight and obesity (n=3),[59–61] tobacco smoking (n=1),[62] and a combination of risk factors (n=17)[63–79] as shown in Supplemental Table S2. The largest proportion of surveyed regions in the published studies were the Southern (n=21) and Highland (n=16) regions of PNG (Table 1).

Quality assessment

Using the JBI critical appraisal checklist for cross-sectional and prevalence studies, 20 studies checked ⩾80% of the items on the checklist. The majority (49%) of the studies rated between 60% and 80%, and none of the papers rated below 50%; thus, no studies were excluded as a result of poor quality. The strengths included the validity of the exposure measurement and appropriate description of the subject/site (see Supplemental Appendix 4).

NCDs and risk factors

Prevalence of T2DM. As shown in Supplemental Table S1, the prevalence of T2DM ranged from 0% in studies among civil servants residing in Port Moresby[26] and a population from Goroka, Eastern Highland Province (EHP) in the 1980s[29] to 20.4% among Port Moresby residents in 2001.[33] Seven studies defined T2DM as a condition characterised by hyperglycaemia as per WHO diagnostic criteria: fasting

Table 1. Summary of the characteristics of the included articles..

Number	Author	Study design, response rate, target age group, gender	Target population, province, region	Type of NCD or risk factor as primary outcome of interest reported	Adult participants (total)
Diabetes mellitus					
1	Benjamin[33]	Cross-sectional study, NR, 12+, males and females	Port Moresby residents, NCD, Southern region	Diabetes mellitus type 2	235
2	Lindeberg et al.[32]	Cross-sectional study, 42%, 20+, males and females	Kitava Island, Milne Bay Province, Southern region	Blood insulin and glucose	170
3	Dowse et al.[31]	NR, 73.7%, 25+, males and females	Koki, Port Moresby, Wanigela and Kalo, Central Province, Southern region	Diabetes mellitus	1402
4	King et al.[30]	Cross-sectional study, 91%, 60%, 78%, 20+, males and females	Gamog, Marup and Kaul, Madang Province. Momase region	Diabetes mellitus type 2	637
5	King et al.[29]	Community survey, >87%, adults, males and females	Asaro, EHP and Matupit, Napapar in East New Britain Province. Highlands and New Guinea Islands region	Diabetes mellitus type 2	799
6	Patel et al.[28]	Community survey, >34%, 18+, males and females	Wanigela, Central Province. Southern region	Diabetes mellitus type 2	192
7	King et al.[27]	Prospective study, 95%, 20+, males and females	Asaro, EHP. Highlands Region	Diabetes mellitus type 2	324
8	Martin et al.[26]	Cross-sectional study, NR, 18+, males and females	Civil servants, Port Moresby, NCD. Southern region	Diabetes mellitus type 2	118
9	Martin et al.[25]	Community survey, 28% rural, 30% urban, 18%, males and females	Rural Kalo, Central Province, urban Koki, Port Moresby, NCD. Southern region	Diabetes mellitus type 2	290
10	Price and Tulloch[24]	Household survey, >88%, 20+, males and females	Port Moresby, NCD. Southern region	Diabetes mellitus type 2	3313
11	Hingston and Price[23]	Community survey, NR, 20+, males and females	Hula, Central Province, Port Moresby, NCD. Southern Region	Diabetes mellitus	1464
Chronic lung disease/asthma					
12	Woolcock et al.[39]	Cross-sectional study, NR, 20+, males and females	Asaro Valley, EHP, Highlands region	Asthma and chronic airflow limitation	743
13	Dowse et al.[38]	NR, NR, 20+, males and females	Goroka, EHP, Highlands Region	Asthma	404
14	Woolcock et al.[37]	Cross-sectional, NR, 20+, males and females	South Fore, EHP. Highlands region	Asthma	1817
15	Anderson[36]	Cross-sectional study, 95%, 15+, males and females	Lufa, EHP, Highlands region	Asthma, respiratory abnormalities, lung function defect, and smoking habits	1284
16	Anderson[35]	Community study, NR, adults, males and females	Lufa, EHP, Highlands region	Asthma	122
17	Woolcock and Blackburn[34]	Epidemiology and longitudinal study, NR, 20+, males and females	Enga and Chimbu natives, Enga and Chimbu Province, Highlands region	Chronic lung disease	717
Cardiovascular disease					
18	Lindeberg and Lundh[41]	Cross-sectional study, 63% (>50 years), 45% (<50 years), 20+, males and females	Kitava Island, Milne Bay Province, Southern region	Stroke and ischaemic heart disease	213 but ECG on 171
19	Sinnett and Whyte[40]	Cross-sectional, 95%, 15+, males and females	Murapin, Enga Province. Highlands region	Cardiovascular disease	779

(continued)

Table 1. (Continued)

Number	Author	Study design, response rate, target age group, gender	Target population, province, region	Type of NCD or risk factor as primary outcome of interest reported	Adult participants (total)
Cancer					
20	Thomas et al.[43]	Cross-sectional study, 74%, 18+, males and females	Kavieng, New Ireland Province, New Guinea Islands region	Leukoplakia, smoking, and chewing betel nut	1678
21	Pindborg et al.[42]	NR, NR, 20+, males and females	Central, Madang and Western Highlands Provinces. Southern, Momase and Highlands regions	Leukoplakia, smoking, and chewing betel nut	1226
Hypertension					
22	Benjamin[52]	Cross-sectional study, NR, 20+, males and females	Koki, Mt. Obree, Balopa, Upper Strickland river. National Capital District, Central, Manus and Southern Highlands. Southern, NGI and Highlands region	Hypertension	1491
23	Ulijaszek[51]	Cross-sectional, NR, 18+, males and females	Baroi and Purari Delta, Gulf Province. Southern region	Hypertension	103
24	Schall[50]	NR, NR, adults, males and females	Pere, Manus Province, New Guinea Islands region	Hypertension	173
25	King et al.[49]	Cross-sectional study, 85% and 78% and 60% for Karkar only, NR for Tolai and Masilkaiufa, 20+, males and females	Karkar Island, Matupit and Napapar, Masilkaiufa. Madang, East New Britain Province, EHP. Momase, NGI and Highlands regions	Hypertension and other CVD risk factors	1455
26	Carvalho et al.[48]	Community study, NR, 20+, males and females	Kamus and Gimisave, EHP, Highlands region	Blood pressure	162
27	King et al.[47]	Cross-sectional study, 95%, 20+, males and females	Asaro Valley, EHP, Highlands region	Hypertension	308
28	Maddocks[46]	Community study, NR, 15+, males and females	Chimbu, Kapuna in Gulf, Hanuabada in NCD, mainland PNG. Highlands, Momase, Southern regions	Blood pressure anthropometry	2155
29	Maddocks and Vines[45]	Community survey, NR, 20+, males and females	New Guinea mainland, Momase, Highlands and Southern regions	Blood pressure, spleen, and lung function	238
30	Maddocks and Rovin[44]	Community survey, NR, 20+, males and females	Mintina, Wandi Gumine, Chimbu Province, Highlands region	Blood pressure	429
Lipids					
31	Lindeberg et al.[58]	Cross-sectional study, NR, 20+, males and females	Kitava Island, Milne Bay Province, Southern region	Lipids, body mass index, blood pressure	169
32	Lindeberg et al.[57]	Cross-sectional study, NR, 20+, males and females	Kitava Island, Milne Bay Province, Southern region	Lipids	151
33	Hodge et al.[56]	Cross-sectional study, 46%–88%, 25+, males and females	Koki, Kalo and Wanigela, Asaro Valley. NCD, Central and EHP. Southern and Highlands regions	Lipids, overweight, and diabetes mellitus type 2	1875
34	Iser and Avera[55]	Cross-sectional study, NR, 18+, males and females	Bougainville, Autonomous Region of Bougainville, NGI region	Lipids and obesity	150
35	Erasmus et al.[54]	Cross-sectional study, 100%, 18+, males and females	Port Moresby, NCD, Southern region	Lipids and obesity	148
36	Wyatt et al.[53]	Community study, 17%–20%, 18+, males and females	Kalo in Central Province, Koki in NCD. Southern region	Lipids	180

(continued)

Table 1. (Continued)

Number	Author	Study design, response rate, target age group, gender	Target population, province, region	Type of NCD or risk factor as primary outcome of interest reported	Adult participants (total)
Overweight/obesity					
37	Benjamin[61]	Community survey, 88.2% anthropometry, 80% for blood sampling, 20+, males and females	Koki, Mt Obree, Balopa, Upper Strickland. NCD, Central, Manus and Southern Highlands Province. Southern, NGI and Highlands	Overweight/obesity	1491
38	Ulijaszek[60]	NR, NR, 20+, males and females	Purari Delta, Gulf Province. Southern region	Overweight and obesity	270
39	Norgan[59]	Community survey, NR, 20+, males and females	Karkar Island, Madang Province and Lufa, EHP, Momase and Highlands region	Modernization, anthropometry, overweight	1094
Tobacco smoking					
40	Vallance et al.[62]	Community survey, 96%, 15+, males and females	Lufa, Eastern Highlands Province, Highlands region	Tobacco smoking	544
Combined NCD risk factors					
41	Yamauchi[79]	NR, NR, 20+, males and females	Huli, Hela Province, Highlands region	Physical activity levels, anthropometry, body fat	253
42	Kende[78]	Cross-sectional study, NR, 25+, males and females	Tari and Port Moresby, Hela and NCD. Highlands and Southern region	Obesity and lipids	221
43	Natsuhara et al.[77]	NR, NR, 20+, males and females	Huli and Balopa migrants in Port Moresby, NCD, Southern region	Hypertension, lipids, obesity, smoking, alcohol	173
44	Lindeberg et al.[76]	Cross-sectional study, 42%, 20+, males and females	Kitava Island, Milne Bay Province, Southern region	Blood pressure, lipids, body mass index, tobacco smoking	203 anthropometry, 162 for blood sample
45	Hodge et al.[75]	Cross-sectional study, 77%, 25+, males and females	Wanigela, Central Province, Southern region	Microalbuminuria, cardiovascular factors and insulin resistance, DM	359
46	Hodge et al.[74]	Cross-sectional study, NR, 25+, males and females	Koki, NCD. Southern region	Hypertension, obesity, lipids and diabetes mellitus type 2	285
47	Hodge et al.[73]	Cross-sectional study, 46%–88%, 25+, males and females	Koki, Kalo and Wanigela, Asaro valley. NCD, Central and EHP. Southern and Highlands regions	Modernity and obesity	1875
48	Lindeberg et al.[72]	Cross-sectional study, 59% (>50 years) 40% (<50 years), 14–87	Kitava Island, Milne Bay Province, Southern region	Lipids, blood pressure, body mass index, skinfold thickness, smoking	270 for anthropometry, 180 for blood sample
49	Scrimgeour et al.[71]	Cross-sectional study, NR, 17+, males and females	Asaro, EHP, Highlands region	Lipids, diabetes mellitus type 2, smoking	121
50	Date et al.[70]	Community study, 79%–88%, 15+, males and females	Beha District, EHP, Highlands region	Anthropometry and blood analysis	440
51	Inaoka et al.[69]	Community study, NR, 20+, males and females	Gidra, Western Province. Southern region	Blood pressure and body mass index, urinary sodium	250

(continued)

Table 1. (Continued)

Number	Author	Study design, response rate, target age group, gender	Target population, province, region	Type of NCD or risk factor as primary outcome of interest reported	Adult participants (total)
52	Boyce et al.[68]	NR, NR, 21+, males and females	Karkar Island, Madang Province, Momase region	Blood pressure, body mass index, lipids	440
53	Hornabrook et al.[67]	Community study, NR, 15+, males and females	Karkar Island, Madang Province, Lufa in EHP, Momase and Highlands regions	Socioeconomic status, anthropometry, blood pressure, and cholesterol	1982
54	Hornabrook et al.[66]	Community study, NR, all ages, males and females	Karkar Island in Madang province, Lufa in EHP. Momase and Highland regions	Anthropometry, blood pressure, biochemical parameters	3700, unable to disaggregate adults from general population
55	Barnes[65]	Community study, NR, adults, males and females	Lower Bomai, Yongamuggi, Chimbu Province. Highlands region	Anthropometry, blood pressure, and lipids	488
56	Whyte[64]	Cross-sectional, NR, 20+, males and females	Chimbu and Gulf Provinces. Highlands and Southern region	Blood pressure and body fat	531
57	De Wolfe and Whyte[63]	NR, NR, 20+, males and females	Wabag, Enga Province, Chimbu Province, Gulf Province, Highlands and Southern region	Total cholesterol and lipoprotein, obesity	242

NCD: National Capital District; EHP: Eastern Highland Province; NR: Not reported; ECG: electrocardiogram; NGI: New Guinea Islands; CVD: cardiovascular disease; PNG: Papua New Guinea; DM: diabetes mellitus.

plasma glucose (FPG) >7 mmol/L, 2-h oral glucose (75 g) tolerance test (OGTT) ⩾11 mmol/L, or use of anti-diabetic drugs.[25–31] Of the remaining four studies, one diagnosed diabetes using fasting capillary blood glucose (⩾7.0 mmol/L);[33] two screened urine for glycosuria,[23,24] and applied the OGTT to confirm diabetes among those with glycosuria; and one reported the mean glucose and insulin levels in the studied population.[32]

Prevalence of asthma and CLD. The prevalence of asthma ranged from 0.2%, in a population from Goroka in 1972[35] to 7.3% among the South Fore (EHP) population in 1980.[37] Furthermore, the prevalence of CLD was 11% among a combined general rural population from Enga and Western Highland Province (WHP) in 1967.[34] Five studies reported on asthma, while two reported CLD as the main outcome. Asthma and CLD were diagnosed through combined investigations, including clinical history, lung function test, and histamine inhalation test (HIT).

Prevalence of CVD. Only two studies have reported on the prevalence of coronary heart disease; one was conducted in the Enga Province in the Highland region in 1966,[40] and the other was from Kitava Island in Milne Bay Province in the southern region in 1990.[41] The former study reported a 6.9% prevalence of coronary heart disease based on history of angina and claudication, and was supported by relevant clinical electrocardiographic (ECG), radiological, and biochemical findings. Abnormalities suggestive of heart disease (8%) were found by ECG among the Kitava population; however, this was considered inconclusive for coronary heart disease.

Prevalence of cancer. Only two published articles have reported on the prevalence of leukoplakia,[42,43] a premalignant lesion of the oral mucosa, based on history and oral mucosa examination. The former study was conducted between 1958 and 1963 in two coastal villages and one highland province. The reported overall prevalence of leukoplakia was 4.6% among the population of the coastal communities, and reported a higher prevalence compared to the highland community.[42] The latter study was conducted in 1992 in a coastal community in New Ireland Province.[43] The overall prevalence of leukoplakia was reported as 11.7%. Similar to the previous study, a high prevalence of leukoplakia coincided with a high prevalence of betel nut chewing.

Prevalence of individual NCD risk factors. As shown in Supplemental Table S2, 36 studies reported the prevalence of one or more NCD risk factors as the primary outcome; these risk factors included hypertension, dyslipidaemia, alcohol consumption, overweight and obesity, betel nut chewing and tobacco smoking, and a diet high in fat and salt.

Hypertension. Nine studies reported high blood pressure as the primary outcome.[44–52] However, only six reported the prevalence of hypertension, which was defined as blood pressure ⩾140/90 mm Hg in five studies[48–52] and ⩾160/95 mm Hg in one study; the remaining three studies only reported the mean blood pressure. The prevalence of hypertension was reported to be as high as 19.7% in a countrywide study conducted between 1996 and 2000,[52] and as low as 0.8% in an Asaro population in the EHPs in 1989.[48]

Dyslipidaemia. Six studies reported on lipids as the primary outcome. Of these, only three articles reported the prevalence of high cholesterol levels, two of which also reported high triglyceride levels, while the remaining three only presented the mean levels.[53,57,58] The prevalence of high cholesterol and triglyceride levels was as high as 26% and 11.9%, respectively, in a study of National Capital District (NCD) residents, and as low as 8% and 6.9%, respectively, in a combined EHP and central study population. For studies that reported high cholesterol levels, two studies[54,56] used 5.2 mmol/L, and one study used 5.5 mmol/L as cut-off levels.[55]

Overweight and obesity. The prevalence of overweight ranged from 4.8% in a study of rural populations from Karkar Island, Madang (MR) and Lufa, and EHP (HR) in the 1990s[59] to 28.4% in 2007 in a combined population from Port Moresby (SR), Central (SR), Southern Highlands Province (HR), and Manus (NGI).[61] Three studies measured and reported the prevalence of overweight and obesity as the main outcome. In two studies, overweight and obesity were defined as a body mass index (BMI) ⩾25 and ⩾30 kg/m^2, respectively,[60,61] while the third study defined obesity as a BMI ⩾25 kg/m^2.[59] The prevalence of obesity (14.1%) and overweight (28.4%) was the highest in a study on a combined group of people from Port Moresby, Manus, Central, and SHP, that was conducted between 1999 and 2002.[61]

Tobacco smoking. Only one study reported tobacco smoking as the primary outcome;[62] this was a study in the Eastern Highlands, which reported the prevalence of tobacco smoking among an adult population. The overall prevalence of tobacco smoking was 52.9% and was the highest among males compared to females.

Studies that reported multiple NCD risk factors. Seventeen studies, as shown in Supplemental Table S2, reported on multiple risk factors, including adiposity, obesity, hypertension, high lipids, high glucose and microalbuminuria, tobacco smoking, alcohol consumption, and salt consumption. Of the three studies[64,69,79] that reported on adiposity, two presented the prevalence, while the third reported the mean. The highest prevalence of body fatness (21.5%) was reported in a study conducted among a group of Tari people (SHP, Highlands) between 1994 and 1995.[79]

BMI was measured in 14 studies,[63,66–70,72–79] but the prevalence of obesity (⩾30 kg/m^2) was reported in only six. The overall obesity prevalence ranged from 38.6% in a study conducted in 1991 among the Koki people living in Port Moresby,[74] which was absent in a study of Chimbu (HR) people in the 1950s.[63]

Blood pressure was measured in 13 studies;[63–70,72,74–77] however, the prevalence of hypertension was reported in only four articles, of which, three define hypertension as >140/90 mm Hg. The reported prevalence ranged from 16.8% among the Koki people of Port Moresby in 1991[74] to 0.4% in a study of people from Chimbu in 1965.[65]

Only one study has reported on the prevalence of microalbuminuria[75] in an urban population. Microalbuminuria was defined as 20–200 µg/mL, and the prevalence of microalbuminuria among the urban population of Koki in Port Moresby was 40.5%.

Lipid levels were measured in 13 studies,[63,65–68,70–72,74–78] although only five reported on the prevalence of high cholesterol.[63,65,71,77,78] The prevalence of high cholesterol levels ranged from 17% in a study conducted in 1997 among Tari people[78] to complete absence in three studies conducted in the 1950s–1960s in Chimbu Province and EHP in 1988.[63,65,71] Only one study[77] reported the prevalence of low high-density lipoprotein cholesterol (HDL-c) (47.4%) and high lipoprotein A (21.4%); this study was conducted in 1995 on a group of people living in Port Moresby, who migrated from Tari in Hela Province and Balopa in Manus Province.

The prevalence of tobacco smoking was reported in four studies,[67,71,76,77] with two reporting daily use of tobacco.[71,76] The overall prevalence was reported to be as high as 77% in a study conducted in 1990 among the Kitava people of the Milne Bay Province.

Alcohol use was reported in two studies,[67,77] neither of which specified how this was measured, with the highest prevalence of 42% from the study conducted in 1995 in Port Moresby.[77] There were only two studies that measured salt consumption but did not present any prevalence data.[65,69]

Discussion

This systematic review reports on published studies that were conducted in PNG between 1950 and 2007. It is difficult to draw conclusions about the prevalence and risk factors of NCDs because of the limited amount of data, disparate ethnic groups, and the fact that the majority of studies were not recent. However, our findings suggest an increase in NCD prevalence across PNG, particularly in relation to T2DM and risk factors such as hypertension, overweight, and obesity, but there remains a lack of recent data. Importantly, the findings further suggest that populations with longer and greater exposure to modernisation, such as those living in urban areas, those with increasing and easy access to pre-packaged food (as opposed to traditional local food), and those with a genetic predisposition tended to have

a higher prevalence of CVD risk factors. Most studies were conducted over two decades ago, most likely due to the limited attention given to NCDs and the lack of funding and capacity to conduct studies on a regular basis.

The majority (n = 9) of the studies on T2DM were conducted in the Southern region, specifically in the Central Province and Port Moresby. Populations living in these two provinces have had longer exposure to modernisation than most other regions of PNG. In addition to lifestyle changes, there is evidence to show that the Motuans, who are of Austronesian ancestry, in the Central Province have a genetic predisposition to T2DM.[29,31] Hence, it is not surprising to find a higher prevalence of T2DM in urban or peri-urban communities, such as Koki in Port Moresby, compared to villages in rural Central Province.

In urban settings, it is evident that an increasing proportion of the diet consists of high-energy processed food purchased from shops, whereas garden produce is being consumed less. As reported in the 2007/2008 PNG STEPS survey, the majority of the surveyed population consumed less than the recommended daily servings of fruit and vegetables.[80] Furthermore, adults living in cities and urbanised areas are more likely to be engaged in sedentary employment compared to the more strenuous subsistence farming and gardening that are common in rural areas.[25,31,81] This was evident in the study by Kende, who reported a significantly higher prevalence of CVD risk factors among a group of people living in Port Moresby who originated from the rural highlands. It was reported that those who migrated to the city to live were less active, had a higher mean body weight, lipids, and glucose compared to their rural counterparts who were still living in the village.[78]

Our review only found two studies that reporting the prevalence of CVD in the general population, both of which were conducted over two decades ago. Considering the high prevalence of CVD risk factors reported here, and the growth of PNG's economy over the past decade,[82] the current burden of CVD is likely to be substantially higher than that indicated in these dated publications.

All studies on CLD/asthma were conducted in the Highlands region, the majority of which were in the EHP at the headquarters of the country's national research institute. The EHP is located at an altitude of 1500 m above sea level, with warm weather during the day and often cold nights. Village people living in traditional huts would usually have a wood fire going to keep the hut warm at night. Respiratory infections are the leading cause of admission and death in the highlands provinces due to early childhood bacterial infection, cold weather, and other environmental factors, such as high exposure to air pollution from wood smoke.[83,84] In addition, the prevalence of asthma showed an upward trend among a rural population within the same province, but was lower in the urban population,[38] with an age of onset in adulthood. Environmental factors, in particular house dust mites, were among the precipitating factors in most of the cases,[35,37,38] which is consistent with previous reviews of causative agents for asthma.[85,86]

Our review found only two studies that reported on the prevalence of leukoplakia, a premalignant cancer in the general community. One was conducted more than 50 years ago in one highland and two coastal populations, while the other was conducted in 1992 on an island population. The prevalence of leukoplakia was higher among the island population than in the other study. The lack of research on premalignant cancer is of great concern given the high rates of known risk factors, such as betel nut use and tobacco smoking, across the country,[58,62,80,87] as both are associated with oral cancer.[88–90] A review of the cancer registry published in 1992 showed an increasing incidence of oral carcinoma;[17] however, to date, no study has provided an updated cancer prevalence in the general community.

The prevalence of hypertension ranged from 0 in the 1960s, from rural populations with limited contact with modernisation, to 30.9% and 24.7% in the early 2000s, among rural Manus and urban Port Moresby populations, respectively. The high prevalence does not necessarily reflect widespread increase in hypertension, as both Port Moresby and Manus have had long-term exposure to Western influence; therefore, baseline and follow-up data may not be comparable, even though rural Manus has been exposed to Western-type diet since the 19th century as a consequence of the settlement of European missionaries and Germans. This is consistent with another study from the Purari Delta in the Gulf Province, which reported increased blood pressure and BMI with increasing modernisation.[51] Consistent with the increasing prevalence over the years, the 2007/2008 PNG STEPS survey reported a hypertension prevalence of 8.8% among the population survey.[80] Furthermore, a review on hypertension in LMICs, as well as in a neighbouring Pacific island, showed an increased prevalence of hypertension in urban populations compared to their rural counterparts.[91–93]

The prevalence of overweight and obesity was mainly reported in studies from the Momase and Southern regions. The lowest prevalence was observed in rural communities in Madang and EHP, which showed a minimal increase over the years,[59] while the prevalence was the highest in peri-urban and urban areas in PNG.[55,74,78] However, the 2007/2008 PNG STEPS survey, which was conducted in four different provinces and the NCD, reported a considerably higher prevalence of overweight and obesity; indeed, it was found that 32% of the survey participants have a BMI of $\geqslant 25\,kg/m^2$.[80]

Although not widely reported, the high prevalence of tobacco smoking is consistent with the results of the PNG STEPS survey,[80] as well as a recent survey[94] completed after the review period, which also showed a very high prevalence of tobacco smoking in certain PNG populations. Given that a high prevalence has been documented over time, it is quite possible that PNG is already experiencing a substantial health burden because of smoking; however, its true extent has not yet been documented.

Similarly, alcohol use was not widely reported in the reviewed publications and was poorly defined when it was. The data that were available suggest that alcohol consumption is the lowest in remote or rural populations.[67,77] Globally, there is evidence showing an increased risk of cancers, liver disease, and CVDs with the harmful use of alcohol.[95] In PNG, few people can afford to regularly consume high quantities of commercially produced alcohol; therefore, its use is highest among people living in towns or urban areas with paid employment. In PNG, the health risk more likely to be associated with alcohol use is accidents and injury, as outlined in previous studies, rather than effects of long-term over consumption.[96,97]

Betel nut chewing is relatively understudied given its level of use and cultural importance in PNG. Although it was not a primary outcome, the prevalence of betel nut chewing reported in one of these studies was very high, particularly from a specific population from the coastal area of PNG,[42] which is consistent with a more recent study.[94] Similarly, the PNG STEPS survey also reported that chewing betel nut was highly prevalent among the surveyed participants from four different provinces across PNG and the city of Port Moresby. Associations with oral cancer, and other health-related risks, as seen in other countries[98–101] are a serious concern in PNG that warrants further investigation.

Strengths and limitations

This is the first paper to review articles that have reported on the prevalence of NCDs and their risk factors in PNG. In addition, the findings are based on a methodological quality assessment that ensures a relatively robust evidence base. Various methods are used for data collection and for ascertaining NCDs and their risk factors, which makes it difficult to compare results between these studies. This review was limited to cross-sectional published articles, and therefore would have missed papers reporting on NCD and risk factor prevalence in the grey literature, as well as in other types of studies, such as cohort/case-control and randomised control studies. In addition, some risk factor–related work may have been missed or fallen outside of our search terms, and therefore would not have been included in this review. Furthermore, some of these studies had limited information and/or only reported the mean measurements. Moreover, the small number of studies with a lack of recent data, in addition to the limited information provided in some of the articles, made it difficult to determine the prevalence or mean trends. The studies were conducted in very diverse ethnic groups; therefore, it is impossible to draw conclusions from the general population of PNG. Attempts to follow up on further information proved to be difficult with no current contact details.

Research and policy implications

As indicated by this review, NCD risk factors are not evenly distributed across PNG or across time. Thus, trends across time and between populations cannot be reliably identified based on the currently available information. However, considering the above limitations, available evidence suggests that NCD risk factors are not evenly distributed and have increased over time. The uneven distribution is not only due to the diverse lifestyle of the population but also their genetic diversity. Indeed, as indicated previously, the high prevalence of NCD risk factors among peri-urban and urban populations, as well as within some populations, is further enhanced by the genetic predisposition, especially in populations with Austronesian ancestry.

It is obvious that there is a need for a structured NCD risk factor surveillance and better data, with systematic monitoring across all provinces. Therefore, it is suggested that routine screening for NCDs and their risk factors be integrated into existing healthcare services to enable early detection of high-risk individuals. This will also ensure the consistency of measurement and criteria to identify these conditions, such that combined prevalence data may be obtained for the country.

PNG conducted its first WHO STEPS NCD risk factor survey in 2007/2008.[80] The survey was conducted in four provinces across PNG and the NCD. However, even though the survey achieved a response rate of 80%, it was from a non-randomised sample, and unfortunately, the survey has not been repeated since.

Updated NCD risk factor prevalence data from all provinces across the country will aid policymakers in planning NCD prevention and control strategies in PNG. Considering the geographical difficulties and remoteness of communities in rural areas, the practicalities of funding and setting up surveillance systems with limited infrastructure and capacity of health professionals at all government levels can be a barrier for implementation. Hence, existing platforms, such as the intergrated Health and Demography Surveillance System (iHDSS), are believed to have considerable potential for use as surveillance systems.

Conclusion

This review showed significant variations in the prevalence of NCD and the risk factors across PNG. It also showed that the increased prevalence of NCD risk factors was mainly from peri-urban and urban areas, as well as among genetically predisposed populations, such as the Austronesian language–speaking group of people.

The review identified a great paucity of data on NCDs and their risk factors over the years. There is a lack of updated prevalence data and/or consistency in data collection or surveillance of NCD and their risk factors in most areas across PNG. Thus, countrywide surveillance of NCD and major risk factors should be a priority for the country to enable appropriate monitoring of such diseases to guide appropriate public health interventions. By establishing the prevalence of NCDs and their risk factors, the country can implement strategies to reduce and control the growing NCD disease burden.

Author contributions

P.R. and S.G. conducted the literature search and summarised the included articles. P.R., S.G., and S.N.B. completed the quality assessment of all eligible articles. P.R. was responsible for the synthesis of the findings and draughting of the manuscript. S.G., S.N.B., J.P., B.M., and B.O. reviewed the manuscript. The final draft was approved by all the authors.

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Supplemental material

Supplemental material for this article is available online.

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