（資料）

社会疫学調査用

中国 FANGSHAN STUDY において、の日本語・英語・中国語の質問票

社会学調査

○ 質問項目：日本語

1) 食生活に関して伝統的な考えや実践されてきたこと

2) 運動など身体的な活動に関して伝統的な考えや実践されてきたこと

3) 過去と現在における健康に関する知識・態度・行動

4) 家族やコミュニティとの関係性が健康に与えてきたことならびに健康に関する知識・態度・行動に影響を与えてきたこと

5) 生活習慣病問題を軽減するためのアイデアや方法

○ 質問項目：英語

Research Questions

1. What are some of the traditional beliefs/practices relating to diet and food in the old days?
2. What are some of the traditional beliefs/practices which relate to physical activities?
3. Knowledge, attitudes and behavior for health? How have knowledge, attitudes and behavior for health affected Palau in the past and today?
4. How have relations with family and community affected people's health? What are some of the situations which have affected people's knowledge, attitudes and behaviors about health?
5. What are your ideas/strategies for making positive changes or for reducing non-communicable diseases?

○ 質問項目：中国語

○ 研究内容（问卷项目）：

1）饮食生活方面，有哪些传统观念和习惯？

2）有 关的体育活动方面有哪些传统观念和习惯？

3）过去和现在对健康的知识、态度和行为习惯？

4）家庭和社区给人们的健康所带来的影响？ 以及人们对健康的知识、态度和行为所带来的影响？

5）为了身体健康、为了减少非传染疾病，有什 么方法或有什么想法？

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分担研究報告書

東アジア、オセアニアにおける生活習慣病対策推進のための学際的研究
—東アジア、東南アジア、オセアニア諸国における生活習慣病危険因子のパターン化—

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研究要旨

生活習慣病 (NCD)の有病率は、低·中所得国で増加し続けており、公衆衛生と経済発展を脅かしている。しかし、国によってNCDの代謝危険因子は異なる。本研究の目的は、東アジア、東南アジア、オセアニア諸国を、NCD代謝危険因子の類似度によりパターン化することである。方法としては、世界保健機関 (WHO) の既存統計データから、東アジア、東南アジア、オセアニアの合計28カ国の、肥満、高血圧、高血糖、高コレステロール血症の有病率データを収集し、階層的クラスター分析を使い、パターン化を行った。

分析の結果、3つの主要なパターンが確認された。各パターンに分類された国々の所得水準や地理的特性に応じて、それぞれ、「高所得アジア型」、「低所得アジア型」、「太平洋島嶼型」と呼ぶこととした。「高所得アジア型」の特徴は、高コレステロール血症の有病率が比較的高く、肥満、高血圧、高血糖の有病率は比較的低いことであった。「低所得アジア型」の特徴は、高血圧の有病率が比較的高く、肥満、高血糖、高コレステロール血症の有病率は比較的低いことであった。「太平洋島嶼型」では、肥満の有病率が高く、高血圧と高血糖の有病率は比較的高かった。

以上の結果より、各パターンに分類された国々は、そのパターンの特徴に応じて、効果的なNCDの予防戦略を優先する必要があることが明らかとなった。

A．研究目的

低･中所得国において、経済発展に伴う生活習慣と食生活の変化により、虚血性心疾患、脳卒中、糖尿病を始めとする生活習慣病 (Non-communicable Diseases: NCD) の増加がますます危惧されている。WHO によると、2008 年には虚血性心疾患による死亡が 730 万人で、世界の死因の一位を占め、その中で低･中所得国よりの死亡は 80%を占める。

低･中所得国のヘルスセクターは母子保健サービスや感染症の制御プログラムは成功してきたが、NCD に対しては、効果的な予防介入や長期的治療を国民に提供できる準備が整っていない。低･中所得国における NCD 対策は、すべての人々の医療保障の達成、すなわち 2015 年以降の開発アジェンダの実現のためには重要なことである。

NCD は世界で共通の問題として取り上げられているが、優先課題としては、その国の遺伝的背景、生活習慣や環境、社会経済的状況に応じて異なる。例えば、米国の主要な課題は、肥満、高血糖、高コレステロール血症であり、従って、中、大動脈のアテローム性動脈硬化症が多い。一方日本は、1960 年代から 70 年代の間、肥満者が少ないにも関わらず、高血圧による小動脈硬化症が原因の脳卒中は全死因の一位を占めていた。世界各国を NCD の代謝危険因子の特徴に応じて分類することは、政策立案者がより効果的な制御戦略を作るのに有用である。

東アジアと東南アジアではまだ肥満者は多くないが、過去数十年間の急速な経済発展に伴い、ライフスタイルに劇的な変化が起き、NCD が主要な公衆衛生上の問題として認識されてきた。一方、オセアニア諸国、特に太平洋島嶼地域では肥満者の割合が極めて高いことが知られている。

本研究は、東アジア、東南アジア、オセアニア地域の様々な所得水準の諸国について、WHO の既存統計データから、NCD の代謝危険因子である肥満、高血圧、高血糖、高コレステロールの血症の有病率を収集した。そして、代謝危険因子の類似度によりこれらの国をパターン化し、政策立案者に優先介入戦略を作成できるよう、手がかりを提供することを目指した。

B．研究方法

本研究は、東アジア、東南アジア、オセアニアの 28 カ国を対象国とした。NCD の代謝危険因子である肥満、高血圧、高血糖、高コレステロール血症の国別の年齢調整有病率は、WHO Global Health Observatory Data Repository から入手した。肥満は、Body Mass Index (BMI) >= 30kg/m^2、 高血圧は、収縮期血圧>= 140mmHg あるいは治療中のもの、高血糖は、空腹時血糖値>= 7.0 mmol/L あるいは治療中のもの、 高コレステロール血症は、血中総コレスレロール値 >= 5.0 mmol/L と定義した。

28 カ国を NCD の代謝危険因子の類似度によりパターン化するために、上記の 4 つの変数に対して標準化を行い、z スコアを算出した。そして、平方ユークリッド距離及びグループの平均連結による階層的クラスターで分析を実施した。

各パターンにおける、肥満、高血圧、高血糖、高コレステロール血症の有病率の平均 z スコアは、各パターンに分類された国々の z スコアを合計し、国の数で割って算出した。

分散分析（ANOVA）及び多重比較分析は IBM SPSS Statistics 20.0 を用い、有意水準は P<0.05 と設定した。

(倫理面への配慮)

本研究は、疫学研究に関する倫理指針を遵守しており、名古屋大学医学部生命倫理委員会より、研究計画を承認されている (承認番号: 2012-0103)。文献資料を直接引用する際は、出典を明らかにして、著作権保護に留意した。

C．研究結果

1. 東アジア、東南アジア、オセアニア諸国の生活習慣病危険因子パターン

東アジア、東南アジア、オセアニアの28カ国は、NCDの代謝危険因子の類似度により3つのパターンに分類された。 Rescaled Distance Cluster Combine を、レベル15の部分で切ると、大きく3パターンに分けられた。所得水準や地理的特性に応じて、それぞれ、

「高所得アジア型」、「低所得アジア型」、「太平洋島嶼型」と呼ぶこととした。

「高所得アジア型」における高コレステロール血症の平均 z スコア (0.9608) は、「低所得アジア型」(-0.9275)、「太平洋島嶼型」(0.1589) より、有意に高かった。「低所得アジア型」の高血圧の平均zスコア(0.1963)は、「高所得アジア型」(-0.9142)より有意に高い($P = 0.009$)ものの、「太平洋島嶼型」と比べ、差は検出できなかった ($P = 0.368$)。「太平洋島嶼型」における、肥満の平均 z スコア (1.1622) は、他の 2 パターンより顕著に高く、高血圧の平均 z スコア (0.5351)、高血糖の平均 z スコア(1.1421) も比較的高かった。

2. 「高所得アジア型」

「高所得アジア型」の特徴としては、高コレステロール血症の有病率が比較的高く、肥満、高血圧、高血糖の有病率が低いことである。このパターンに分類された国の多くは、高所得国及び上位中所得国であった。

血中総コレステロール値が高値であることは、虚血性心疾患の強力な危険因子であることはよく知られている。これらの国では、予想される高い虚血性心疾患の罹患率及び死亡率を予防するために、血中総コレステロール値を低下させる介入を優先すべきである。可能な介入として、飽和脂肪の摂取量を減らして食物繊維の摂取を推奨すること、及び高コレステロール血症をスクリーニングするとともに、継続的な治療を提供することが考えられる。

3. 「低所得アジア型」

「低所得アジア型」の特徴としては、高血圧の有病率が比較的高く、肥満、高血糖、高コレステロール血症の有病率が低いことである。アジアにおける低所得国及び下位中所得国のほとんどは、このパターンに分類された。

高血圧は、脳卒中の最も重要な危険因子であり、世界中の脳卒中負担の 3 分の 2 を占めている。これらの国では、いち早く適切な健康教育と栄養指導を通じて、食事の塩分摂取量を減らすこととともに、定期的に高血圧スクリーニングを行うべきである。また、生涯にわたり降圧薬治療へアクセスできるよう、医療体制を確保する必要がある。

4. 「太平洋島嶼型」

「太平洋島嶼型」に含まれたのは、オセアニアの低･中所得島嶼国であった。このパターンでは高い肥満の有病率と比較的高い高血圧、高血糖の有病率が特徴である。

これらの国において、肥満及び高血圧、高血糖に対する効果的な予防対策を立てないと、近い将来に脳卒中と糖尿病の罹患率と死亡率が更に上昇することが予想される。食習慣や身体活動を改善するためのシステマティックな公衆衛生上の介入が早急に必要とされる。

5. NCD 危険因子パターン転換の可能性

本研究では、東アジア、東南アジア、オセアニアの国々を、NCD の代謝危険因子により 3 つのパターンに分類したが、ある 1 つの国がいつまでも同じパターンに留まるわけではないと考えられる。社会的、経済的発展に伴い、人々のライフスタイルや栄養状態は変化するし、それに伴って、NCD 危険因子も変わってくる。体系的な公衆衛生上の介入が、NCD の代謝危険因子の変化をもたらすこともある。

例えば、日本は、現在、「高所得アジア型」に分類されているが、1960 年代から 70 年代は高血圧の有病率が高く、本研究での「低所得アジア型」の国々と類似した状況であった。その後、日本では、健康教育や塩分摂取量を減らす栄養指導が普及し、また地域や職場での高血圧のスクリーニングが行なわれ、安価で継続可能な抗高血圧治療が提供されてきた。このような体系的な公衆衛生上の介入が行われたことにより、日本人の収縮期血圧の低下に成功した。

日本では、高度経済成長期以降 20～30 年を経て、NCD 代謝危険因子のパターンに、明らかな変化が起きている。これは、現在、「低所得アジア型」に分類されている、東アジア、東南アジアの低所得国及び下位中所得諸国においても、急激な経済成長から 20～30 年後には、NCD 代謝危険因子が「高所得アジア型」に転換する可能性を示唆している。早急に体系的な高血圧対策が実施されないと、これらの国々では、近い将来、高血圧と

高コレステロール血症による二重の負担が生じることが予想される。

6. 本研究の限界と今後の展望

本研究は、東アジア、東南アジア、オセアニア諸国を、NCD 代謝危険因子の類似度によりパターン化することに着目した最初の試みである。WHO データベースから得られた推定有病率データに基づき、我々は 3 つのパターンを見出した。しかし、各国の地域別有病率は入手できなかったため、このデータは各国における全人口を代表していないかもしれない。例えば、中国では、豊かな都市部と貧しい農村地域での NCD 代謝危険因子の分布は異なっている可能性が大きい。

今回は、最初の試みとして、東アジア、東南アジア、オセアニア地域の諸国を対象とした。次の段階は、NCD 代謝危険因子の特徴が多様であると予測される、より大きなアジア地域について検討する必要がある。例えば、中東及び中央アジアにおける肥満の有病率は東南アジアよりもはるかに高いことが知られており、心血管疾患に対する肥満の寄与が東アジアと南アジアでは異なることが報告されている。また、今後の研究では、アフリカ、中南米の諸国も分析に入れるべきであろう。また、今回は、各国間で比較するために、男女合計の推定有病率を使用したが、将来は男女に分けて検討する必要もある。

7. 結論

本研究では、東アジア、東南アジア、オセアニアの 28 カ国を、NCD 代謝危険因子の類似度により 3 つのパターンに分類した。所得水準や地理特性に応じて、それぞれを「高所得アジア型」、「低所得アジア型」、「太平洋島嶼型」と呼ぶこととした。

各パターンに分類された国々は、そのパターンの特徴に応じて、効果的な NCD 予防戦略を立案するべきである。また、将来のパターン転換も考慮すべきである。

D．健康危険情報

該当事項なし

E．研究発表

1. 論文発表

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2. 学会発表等

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F．知的財産権の出願・登録状況

該当事項なし

資料 4

Patterns of Non-communicable Disease Metabolic Risk Factors of the Countries in East Asia, South-East Asia and Oceania

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Abstract

Background and Objective: The prevalence of non-communicable diseases (NCD) is increasing in low- and middle-income countries, imposing a major public health and development threats. However, there is difference among countries with regard to the patterns of NCD metabolic risk factors. This study aims to categorize the pattern of metabolic risk factors in East Asia, South-East Asia and Oceania.

Methods: We used hierarchical cluster analysis to categorize countries in East Asia, South-East Asia and Oceania based on the prevalence of NCD metabolic risk factors of each country, obtained form the WHO data base.

Results: Three major patterns of NCD metabolic risk factors were identified by our study. According to the income level and geographic characteristics of the majority of the countries categorized in each pattern, the three patterns were labeled as: Higher-income Asian pattern; Lower-income Asian pattern; and Pacific island pattern. Higher-income Asian pattern showed relatively high prevalence of raised blood cholesterol, while prevalence of obesity, raised blood pressure and raised blood glucose remain relatively low. Lower-income Asian pattern presented relatively high prevalence of raised blood pressure, although prevalence of obesity, raised blood glucose, and raised blood cholesterol stay relatively low. Pacific island pattern presented high prevalence of obesity, and relatively high prevalence of raised blood pressure and raised blood glucose.

Conclusions: Countries in each region should set priorities for developing effective NCD control measures according to the features of each pattern.

Key words:

Non-communicable diseases; Risk factors; East and South-East Asia; Oceania; Cluster analysis

Introduction

The prevalence of non-communicable diseases (NCDs), such as ischemic heart diseases, stroke and diabetes, is increasing in low- and middle-income countries, along with economic development, and changes in the lifestyle and nutritional status. The World Health Organization (WHO) estimated that 7.3 million people died from ischemic heart disease in 2008, the highest cause of mortality in the world, and 80 % of the deaths occurred in low- and middle-income countries (1). However, the health sector in those countries has not been ready to provide the entire population with affordable long-term treatment or effective preventive interventions to NCDs, while maternal and child health services and communicable disease control programs have been successfully extended. Controlling NCDs in low- and middle-income countries would be a key factor for achieving universal health coverage, a global initiative for post-2015 development agenda.

While NCDs are common problems throughout the world, priority issues are different depending on the genetic background, lifestyle and environment, and social and economic situation of the population. For example, major issues in the United States are obesity, hyperglycemia, hypercholesterolemia (2), and, as a consequence, atherosclerosis of medium or large arteries. However, in Japan during 1960s and 70s, stroke due to sclerosis of small arteries, which was brought by uncontrolled hypertension, was the highest cause of mortality despite low obesity prevalence (3). It would be useful to classify countries in the world according to the priority NCD metabolic risk factors, so that policy makers would be able to set effective control strategies for the population.

This study aims to categorize countries according to the prevalence of NCD metabolic risk factors, and provide policy makers with a clue to set prioritized intervention strategies. As the first step, we chose countries in East Asia, South-East Asia and Oceania, comprised of various income levels. NCDs are gradually recognized as major public health issues in the countries in East Asia and South-East Asia, where people's lifestyle changed dramatically during the past decades along with the rapid economic development, although obesity prevalence has not been very high yet. In Oceania, obesity prevalence is known to be extremely high, particularly among Pacific islanders (1).

Methods

Age-standardized prevalence of obesity, raised blood pressure, raised blood glucose, and raised blood cholesterol of 28 countries in East Asia, South-East Asia, and Oceania were obtained from the WHO Global Health Observatory Data Repository (4). Standardized z-scores of the above mentioned four variables were included in hierarchical cluster analysis, based on squared Euclidean distance and within groups average linkage, to identify countries with similar pattern of NCD metabolic risk factors (5). We considered all the people in component countries in a pattern as one combined population, and assumed that the WHO data we used was randomly selected from this combined population, although each data was actually sample means of those countries. Then analysis of variances (ANOVA) and multiple comparisons were conducted by using IBM SPSS 20.0 and statistical significance was set at the level of $P < 0.05$.

Results

Three major clusters were revealed by setting the cut-off at the rescaled distance cluster combine level of 15 (Fig. 1). The three clusters were labeled according to the income level and geographic characteristics of the majority of the countries categorized in each cluster as: Higher-income Asian pattern; Lower-income Asian pattern; and Pacific island pattern. Characteristics of the three patterns are shown as radar charts of typical countries categorized in each pattern (Fig. 2),

The population z-score means on each variable and the result of multiple comparisons of populations are shown in Table 1. Higher-income Asian pattern showed the highest raised blood cholesterol z-score mean (0.9608), which was significantly higher than Lower- income Asian pattern and Pacific island pattern (-0.9275 and 0.1589, respectively). Lower-income Asian pattern had higher raised blood pressure z-score means than Higher-income Asian pattern (0.1963 vs -0.9142, P=0.009), although it was not significantly different from that of the Pacific island pattern (P=0.368). The Pacific island pattern, presented extremely higher z-score means in obesity (1.1622) than other two patterns, and z-scores of raised blood pressure (0.5351) and raised blood glucose (1.1421) were also relatively high.

Discussion

Our analysis revealed three major patterns of NCD metabolic risk factors among countries in East Asia, South-East Asia and Oceania.

Higher-income Asian pattern presents relatively high prevalence of raised blood cholesterol, while prevalence of obesity, raised blood pressure and raised blood glucose remain relatively low. Countries which show this pattern are mostly high- and upper-middle-income countries in the regions. It is known that total blood cholesterol is an independent strong risk factor for ischemic heart diseases (6, 7). Therefore, interventions to reduce blood cholesterol levels of the people should be prioritized in these countries for preventing expected high morbidity and mortality of ischemic heart diseases. Possible interventions include promoting to take dietary fibers but not to take saturated fats, screening blood cholesterol levels of people, and providing continuous medical treatment for hypercholesterolemia.

Lower-income Asian pattern presents relatively high prevalence of raised blood pressure, although prevalence of obesity, raised blood glucose, and raised blood cholesterol stay relatively low. Most of low- and lower-middle-income countries in Asia are categorized in this pattern. Raised blood pressure is the most significant risk factor of stroke, which bears two thirds of the stroke burden globally (8). It is urgently needed for those countries to control the blood pressure of people by reducing dietary salt intake through proper health and nutrition education, screening blood pressure regularly, and ensuring access to affordable lifelong antihypertensive treatment.

Pacific island pattern, observed uniquely among low- and middle-income insular countries in Oceania, presents high prevalence of obesity, and relatively high prevalence of raised blood pressure and raised blood glucose. People in those countries are likely to suffer from high morbidities and mortalities of strokes and diabetes mellitus in the near future, unless effective control measures against obesity, raised blood pressure and raised blood glucose are taken. Integrated public health interventions for improving diet habits and physical activities are urgently required.

Although we categorized countries in East Asia, South-East Asia, and Oceania into three patterns of NCD metabolic risk factors, countries are unlikely to stay in the same pattern forever. People's lifestyles and nutritional status are changing along with the social and economic development, so will the prevalence of NCD metabolic risk factors. Systematic public health interventions are also expected to bring dynamic changes in NCD metabolic risk factors.

For example, Japan is currently categorized in the Higher-income Asian pattern; however, it had high prevalence of hypertension in 1960s and 70s (3), similar to the countries categorized in the Lower-income Asian pattern. Systolic blood pressures of Japanese people have been successfully lowered through systematic public health interventions, including health education and nutrition consultations for reducing salt intake, screening blood pressures in the local communities and workplaces, and providing affordable continuous anti-hypertensive treatment (3, 9).

The changes in the pattern of NCD metabolic risk factor became apparent two to three decades after the period of rapid economic development in Japan. This suggests that low- and lower-middle-income countries in East Asia and South-East Asia categorized in Lower- income Asian pattern may shift to be categorized in the Higher-income Asian pattern, 20 to 30 years after the ongoing dramatic economic growths. Therefore, unless systematic interventions for controlling hypertension are taken place immediately, these countries may suffer from dual burdens of high prevalence of raised blood pressures and raised blood cholesterol in the near future.

This study is the first step to highlight the features of NCD metabolic risk factors. Based on the estimated prevalence data obtained from the WHO database, we have identified three patterns of NCD metabolic risk factors. Because sub-regional data within each county were not available from the database, the data might not be representative of the whole population in each country; for example, in China, NCD metabolic risk factors might be significantly different between residents in rich urban cities and poor farmers in remote areas.

As the first step, we targeted only East Asia, South-East Asia and Oceania regions. Next studies should cover larger Asian areas, where NCD metabolic risk factor feature is diverse. For example, obesity prevalence in Middle East and Central Asia is known to be much higher than that in East and South-East Asia (4); and obesity in South Asia was reported to have a different effect on cardiovascular diseases from that in East Asia (10). It would also be useful to extend the analysis to other regions such as Africa, and Latin America. Gender differences need to be investigated as well (11), although this study used estimated prevalence for both sexes to ensure comparability across countries.

Conclusion

Three major patterns of NCD metabolic risk factors were identified by our study. According to the income level and geographic characteristics, the patterns were labeled as: Higher-income Asian pattern; Lower-income Asian pattern; and Pacific island pattern. Countries categorized in each pattern should set priorities for effective NCD control strategies according to the features of the pattern Possible pattern transition in the future should also be taken into consideration.

Authors' Contributions

YZ, AA and EHH designed the study. YZ and EHH were involved in the search, collection and summarization of data. YZ, NK, YL and CC analyzed and interpreted the data. YZ wrote the first draft, and AA and HY revised the draft critically. All authors contributed substantial inputs to the successive drafts, and YZ finalized the manuscript.

Conflict of interest

All authors declared that no competing interests exit. Although this study did not require specific funding, the study is a part of a study entitled "Multi-Disciplinary Study for Promoting Non-Communicable Disease Control in East Asia and Oceania," funded by Health and Labour Sciences Research Grants (Research on global health issues), Ministry of Health, Labour and Welfare, Japan. The whole study plan was reviewed and approved by the Ethics Review Committee of Nagoya University School of Medicine, Nagoya, Japan (Approval No. 2012-0103).

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Fig. 1. Dendrogram of the patterns of NCD metabolic risk factors

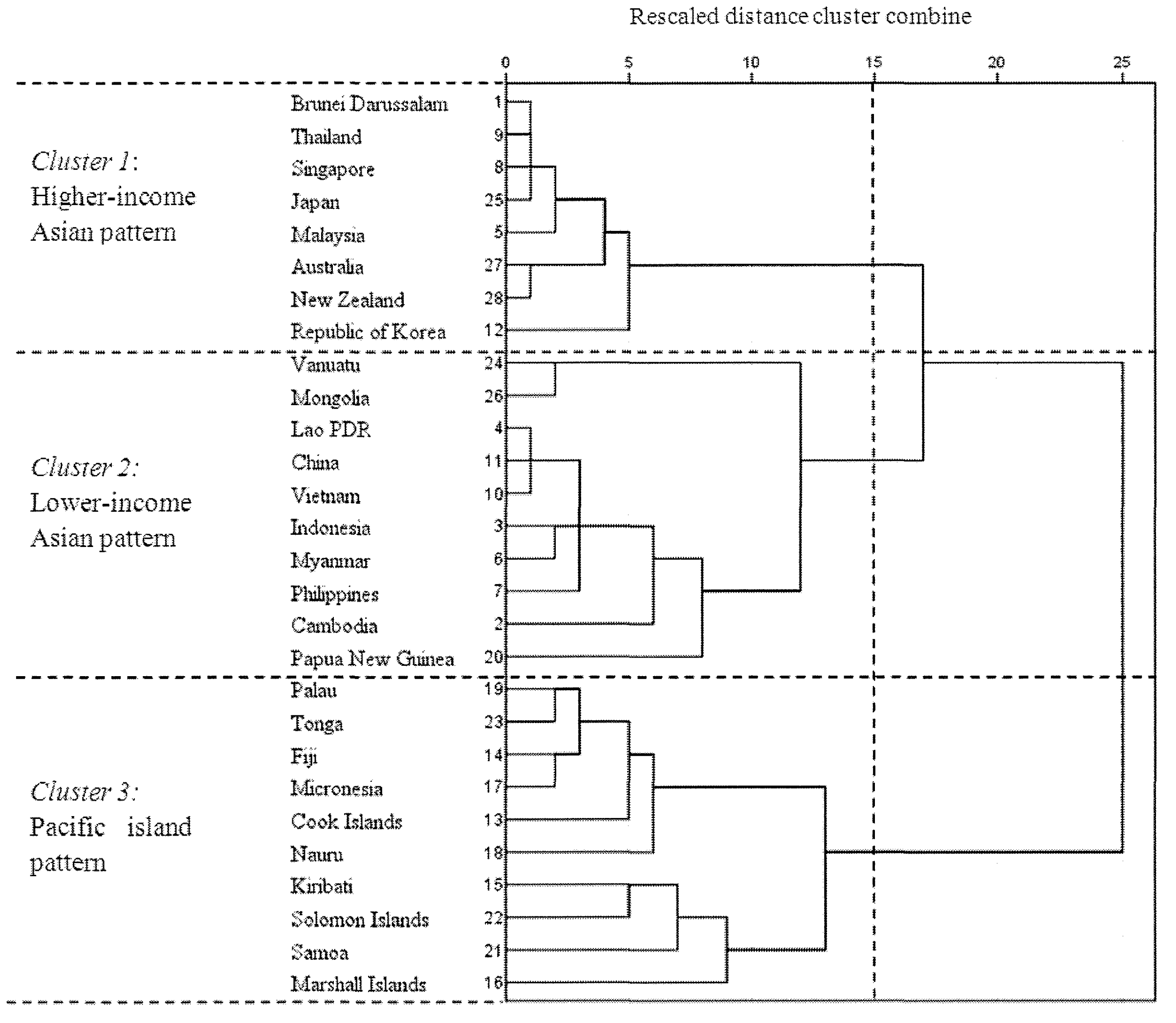
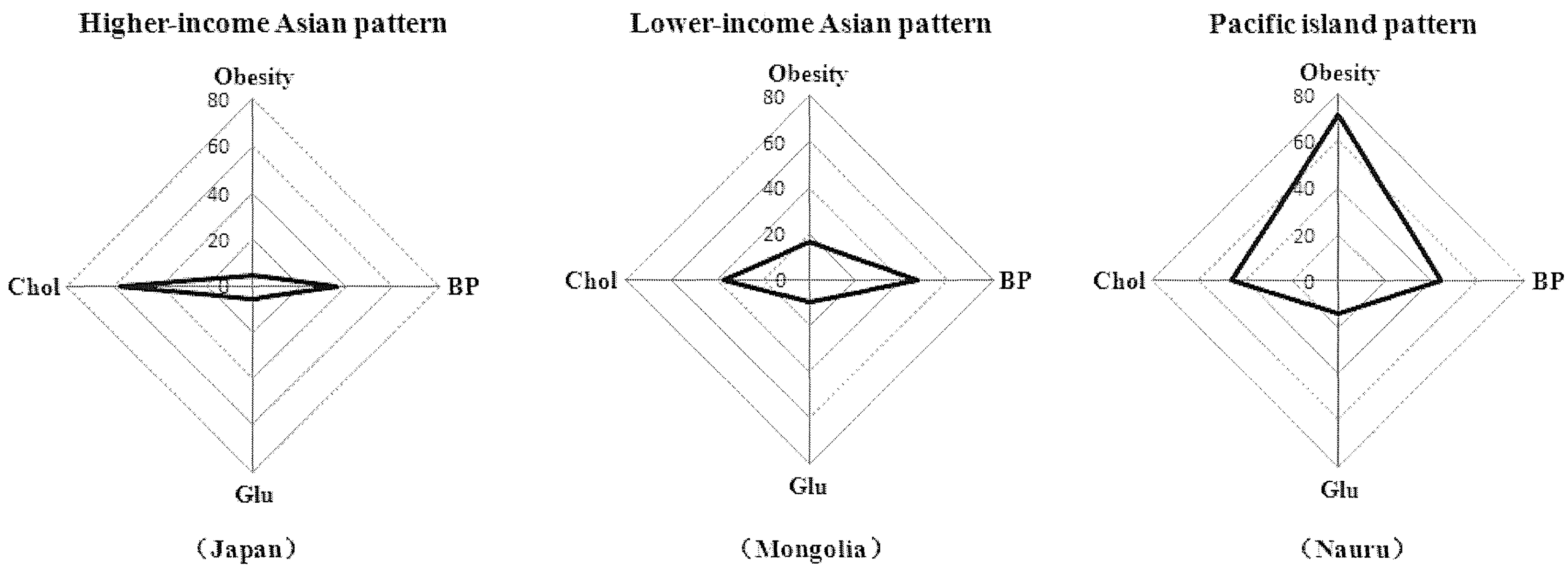


Fig. 2. Radar charts of the three patterns of metabolic risk factors



Typical countries of each pattern are shown. BP: raised blood pressure; Glu: raised blood glucose; Chol: raised blood cholesterol.

Table 1: Characteristics of the three patterns of NCD metabolic risk factors

	Obesity [a] z-score means (SD)	**Raised blood pressure** [b] z-score means (SD)	**Raised blood glucose** [c] z-score means (SD)	**Raised blood cholesterol** [d] z-score means (SD)
Higher-income Asian pattern (n=8)	-0.5533 (0.40)	-0.9142 (0.55)	-0.6871 (0.30)	0.9608 (0.50)
Lower-income Asian pattern(n=10)	-0.7196 (0.41)	0.1963 (1.16)	-0.5925 (0.43)	-0.9275 (0.42)
Pacific island pattern (n=10)	1.1622 (0.60)	0.5351 (0.57)	1.1421 (0.70)	0.1589 (0.91)
ANOVA	F=45.046, P<0.001	F=7.278, P=0.003	F=38.111, P<0.001	F=18.866, P<0.001
Multiple comparisons	(P-value from t-test)			
Higher-income Asian pattern *vs.* Lower-income Asian pattern	0.856	0.027	0.974	<0.001
Higher-income Asian pattern *vs.* Pacific island pattern	<0.001	0.003	<0.001	0.048
Lower-income Asian pattern *vs.* Pacific island pattern	<0.001	0.747	<0.001	0.003

[a] Body Mass Index >= 30; [b] Systolic Blood Pressure >= 140mmHg or on medication; [c] Fasting Blood Glucose >= 7.0 mmol/L or on medication; [d] Total Cholesterol >= 5.0 mmol/L.

研究成果の刊行に関する一覧表

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Hilawe EH, Yatsuya H, Kawaguchi, L, and Aoyama A	Differences by sex in the prevalence of diabetes mellitus, impaired fasting glycaemia and impaired glucose tolerance in sub-Saharan Africa: a systematic review and meta-analysis	Bulletin of the World Health Organization	91 (9)	671–682	2013
Wu N, Tang X, Wu Y, Qin X, He L, Wang J, Li N, Li J, Zhang Z, Dou H, Liu J, Yu L, Xu H, Zhang J, Hu Y, and Iso H	Cohort Profile: The Fangshan Cohort Study of Cardiovascular Epidemiology in Beijing, China	J Epidemiol	24	84–93	2014

研究成果の刊行物・別刷

Differences by sex in the prevalence of diabetes mellitus, impaired fasting glycaemia and impaired glucose tolerance in sub-Saharan Africa: a systematic review and meta-analysis

Esayas Haregot Hilawe,[a] Hiroshi Yatsuya,[b] Leo Kawaguchi[a] & Atsuko Aoyama[a]

Objective To assess differences between men and women in the prevalence of diabetes mellitus, impaired fasting glycaemia and impaired glucose tolerance in sub-Saharan Africa.

Methods In September 2011, the PubMed and Web of Science databases were searched for community-based, cross-sectional studies providing sex-specific prevalences of any of the three study conditions among adults living in parts of sub-Saharan Africa (i.e. in Eastern, Middle and Southern Africa according to the United Nations subregional classification for African countries). A random-effects model was then used to calculate and compare the odds of men and women having each condition.

Findings In a meta-analysis of the 36 relevant, cross-sectional data sets that were identified, impaired fasting glycaemia was found to be more common in men than in women (OR: 1.56; 95% confidence interval, CI: 1.20–2.03), whereas impaired glucose tolerance was found to be less common in men than in women (OR: 0.84; 95% CI: 0.72–0.98). The prevalence of diabetes mellitus – which was generally similar in both sexes (OR: 1.01; 95% CI: 0.91–1.11) – was higher among the women in Southern Africa than among the men from the same subregion and lower among the women from Eastern and Middle Africa and from low-income countries of sub-Saharan Africa than among the corresponding men.

Conclusion Compared with women in the same subregions, men in Eastern, Middle and Southern Africa were found to have a similar overall prevalence of diabetes mellitus but were more likely to have impaired fasting glycaemia and less likely to have impaired glucose tolerance.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Introduction

Increasing urbanization and the accompanying changes in lifestyle are leading to a burgeoning epidemic of chronic noncommunicable diseases in sub-Saharan Africa.[1,2] At the same time, the prevalence of many acute communicable diseases is decreasing.[1,2] In consequence, the inhabitants of sub-Saharan Africa are generally living longer and this increasing longevity will result in a rise in the future incidence of noncommunicable diseases in the region.[1–3]

Diabetes mellitus is one of the most prominent noncommunicable diseases that are undermining the health of the people in sub-Saharan Africa and placing additional burdens on health systems that are often already strained.[4,5] In 2011, 14.7 million adults in the African Region of the World Health Organization (WHO) were estimated to be living with diabetes mellitus.[6] Of all of WHO's regions, the African Region is expected to have the largest proportional increase (90.5%) in the number of adult diabetics by 2030.[6]

Sex-related differences in lifestyle may lead to differences in the risk of developing diabetes mellitus and, in consequence, to differences in the prevalence of this condition in women and men.[3] However, the relationship between a known risk factor for diabetes mellitus – such as obesity – and the development of symptomatic diabetes mellitus may not be simple. For example, in many countries of sub-Saharan Africa, women are more likely to be obese or overweight than men and might therefore be expected to have higher prevalences of diabetes mellitus.[3,7] Compared with the corresponding men, women in Cameroon[8], South Africa[9] and Uganda[10] were indeed found to have higher prevalences of diabetes mellitus. However, women in Ghana,[11] Nigeria,[12] Sierra Leone[13] and rural areas of the United Republic of Tanzania[14] were found to have lower prevalences of diabetes mellitus than the men in the same study areas. No significant differences between men and women in the prevalence of diabetes mellitus were detected in studies in Guinea,[15] Mali,[16] Sudan[17] and urban areas of the United Republic of Tanzania,[18] or in a meta-analysis of data collected in several studies in West Africa.[19] Although wide variations in the distribution of diabetes mellitus by sex have been documented in several review articles,[3–5,7,20] the possible causes of this heterogeneity have never been examined in detail.

Like obesity, impaired fasting glycaemia and impaired glucose tolerance appear to be risk factors in the development of diabetes mellitus.[21,22] According to the International Diabetes Federation, the estimated age-adjusted prevalence of impaired fasting glycaemia in WHO's African Region was substantially higher in 2011 than the corresponding global mean value – 9.7% versus 6.5%, respectively – and is expected to have risen further by 2030.[23]

Impaired fasting glycaemia and impaired glucose tolerance are reported to be metabolically distinct entities that affect different subpopulations, albeit with some degree of overlap.[22,24] In Mauritius, the prevalence of impaired fasting glycaemia was found to be significantly higher in men than in women, whereas the prevalence of impaired glucose tolerance was found to be higher in women than in men.[24,25]

Differences between men and women in the prevalence of diabetes mellitus, impaired fasting glycaemia and impaired glucose tolerance in much of sub-Saharan Africa have yet

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Table 1. **Countries comprising sub-Saharan Africa, by African subregion**[a]

Subregion			
Eastern	**Middle**	**Southern**	**Western**
Burundi	Angola	Botswana	Benin
Comoros	Cameroon	Lesotho	Burkina Faso
Djibouti	Central African Republic	Namibia	Cape Verde
Eritrea	Chad	South Africa	Côte d'Ivoire
Ethiopia	Congo	Swaziland	Gambia
Kenya	Democratic Republic of the Congo		Ghana
Madagascar	Equatorial Guinea		Guinea-Bissau
Malawi	Gabon		Liberia
Mauritius	Sao Tome and Principe		Mali
Mozambique			Mauritania
Rwanda			Niger
Seychelles			Nigeria
Somalia			Senegal
Sudan			Sierra Leone
Uganda			Togo
United Republic of Tanzania			
Zambia			
Zimbabwe			

[a] As designated by the United Nations.[28]

Box 1. **Strategy followed in searching PubMed and the Web of Science**

Various medical subject headings (MeSH) and search terms, including "prevalence", "incidence", "epidemiology", "proportion", "rate", "diabetes mellitus", "hyperglycaemia", "abnormal* blood glucose", "glucose intolerance", "dysglycaemia", "insulin resistance", "metabolic* syndrome", "insulin resistance syndrome X", "cardiovascular syndrome", "hypertension", "increase* blood pressure", "obesity", "overweight", "hypercholesterolaemia", "hyperlipidaemia", "dyslipidaemia", "physical inactivity", "smoking", "cardiovascular diseases risk factors" and "Africa South of the Sahara" – and alternative spellings such as "hyperglycemia" were used. Searches were combined with the names of each country in Eastern, Middle and Southern Africa (Table 1) – except Cameroon, which was included in a previous study on West Africa[19] – by using the Boolean operators "OR" or "AND".

to be reviewed. Given the variation in health care, culture, environment, human behaviour and other determinants of health across sub-Saharan Africa,[26] the conclusions drawn from a recent meta-analysis of data from West Africa[19] should not be assumed to apply to the whole of sub-Saharan Africa. The sex-specific prevalence of at least one risk factor for diabetes mellitus – obesity – is known to differ across different parts of sub-Saharan Africa.[7,27]

The main aims of the present systematic review were to examine differences between men and women in the prevalence of three conditions – diabetes mellitus, impaired fasting glycaemia and impaired glucose tolerance – in Eastern, Middle and Southern Africa (i.e. all in sub-Saharan Africa according to the United Nations subregional classification for African countries),[28] and to explore the possible causes of any variation observed. We followed the Meta-analysis of Observational Studies in Epidemiology (MOOSE) group's guidelines for the reporting of systematic reviews of observational studies.[29]

Methods

Data sources

In September 2011, we searched PubMed and Web of Science for studies that presented the sex-specific prevalences of diabetes mellitus, impaired fasting glycaemia and/or impaired glucose tolerance in Eastern, Middle and/or Southern Africa (Table 1). The medical subject headings (MeSH) and search terms we used are described in Box 1. We limited our search to human studies but placed no restrictions on the language of publication. We also used Google, Google Scholar and WHO's InfoBase to search the "grey" literature for relevant studies and reports. The citations in articles that appeared to be relevant were examined for other articles that might hold useful data. When it seemed possible that relevant data had been recorded but not published, the authors of published study reports were contacted via e-mail to see if they could provide such data.

Inclusion and exclusion criteria

Data were included in the meta-analysis if they came from studies that fulfilled all of the following criteria:

- community-based;
- cross-sectional;
- reported prevalence of diabetes mellitus, impaired fasting glycaemia and/or impaired glucose tolerance;
- reported either odds ratios (ORs) for differences between men and women in the prevalence of diabetes mellitus, impaired fasting glycaemia and/or impaired glucose tolerance or data that allowed the computation of such ORs;
- conducted in apparently healthy, non-pregnant subjects;
- most subjects are adults (i.e. aged ≥ 15 years) and residing in the UN-designated Eastern, Middle or Southern subregions of Africa;
- both men and women investigated;
- employed any of WHO's diagnostic criteria – or the equivalent criteria of the American Diabetic Association – for diabetes mellitus, impaired fasting glycaemia and/or impaired glucose tolerance;[30–38]
- reported results either in English or in another language with an abstract in English.

When multiple reports of the same study were retrieved, only the most informative report was selected. Clinic-, hospital- and laboratory-based studies, anonymous reports, letters, commentaries, case studies and reviews were excluded.

Data abstraction

After reading each article that appeared relevant and met the inclusion criteria, one of the authors (EHH) made notes of the year of study and publication, sampling method, sample size, response rate, study design, diagnostic criteria, study area, mean age and/or age range of the subjects, mean blood glucose level, the recorded prevalences of diabetes mellitus, impaired fasting glycaemia and/

or impaired glucose tolerance, and, if available, the OR and corresponding 95% confidence intervals (CIs) that indicated the type and significance of any differences in these prevalences by sex. When articles presented data separately for urban and rural subjects, information for these two groups of subjects was extracted separately. When articles presented data stratified by subject age, only the data for subjects aged 15 years or older were included in the analysis. All of the extracted data were independently reviewed by a second author (HY).

Quality appraisal

A checklist – adopted from one created by the University of Wisconsin[39] – was used to assess the quality of the included studies. The checklist had eight questions relating to the research question, selection of study subjects, comparability of study groups, handling of withdrawals, measurement of outcomes, statistical analyses, results and conclusions, and funding or sponsorship. If the answers to five or more of these questions were positive, the study involved was categorized as "positive" and considered to be of good quality. If the answers to five or more of these questions were negative, the study involved was categorized as "negative" and considered to be of poor quality. All other studies were categorized as "neutral".

Statistical analysis

ORs were used as "effect estimates" to quantify the relationship between sex and the prevalence of diabetes mellitus, impaired fasting glycaemia and impaired glucose tolerance. If no OR had been reported, it was calculated from the raw data. Since the studies included in the meta-analysis used different standard populations, crude prevalences were preferred to the age-adjusted values when both were available. The DerSimonian and Laird random-effects model was used to estimate the mean OR for all of the studies included in the meta-analysis.[40]

Statistical heterogeneity across the studies was evaluated using both the Q and I^2 statistics.[40] In the Q-tests, a P-value of < 0.1 was considered indicative of statistically significant heterogeneity. We performed subgroup analyses to assess the potential influence of the following study-level covariates on the OR for any sex-specific differences: area of residence (urban or rural), subregion of residence in sub-Saharan Africa (i.e. Eastern, Middle or Southern Africa), study year, ethnicity of the study subjects, and the World-Bank-determined income level of the study country.[41] Random-effects univariate meta-regression analysis[40] was also performed as an extension of the subgroup analyses.

The potential influence of each individual study on the overall summary estimates was assessed by rerunning the meta-analysis while omitting one study at a time. Sensitivity analysis was performed to assess the impact of the quality of the studies on the overall effect estimates. For those studies that reported both crude and age-adjusted prevalences, we also assessed if the effect estimates would have been substantially altered if the age-adjusted values had been used instead of the crude ones.

Publication bias[40] was assessed using a funnel plot to examine the relationship between the effect size and study precision. Begg and Mazumdar's rank-correlation test[40] was then used to test this relationship statistically. Finally, Duval and Tweedie's "trim and fill" analysis was used to assess the possible impact of publication bias on the effect size.[40]

Version 2 of the Comprehensive Meta-Analysis software package (Biostat, Englewood, United States of America) was used for all of the statistical analyses. All statistical tests were two-sided. A P-value of < 0.05 was generally considered indicative of statistical significance.

Results

Literature search

Although the PubMed and Web of Science searches revealed 5129 potentially useful reports, only 25 of these reports were found to satisfy all of the inclusion criteria (Fig. 1). Four additional reports that met all of the inclusion criteria were identified via a Google search ($n = 2$), a search of the WHO InfoBase ($n = 1$) or contact with authors ($n = 1$). The meta-analysis therefore included data from 29 reports that, together, covered 36 studies in which cross-sectional data were collected.[14,17,42–68]

Study characteristics

Table 2 (available at: http://www.who.int/bulletin/volumes/91/9/12-113415) provides detailed descriptive information for the 36 studies included in the meta-analysis. These studies involved 75 928 subjects and were conducted between 1983 and 2009 in Angola, the Democratic Republic of the Congo, Kenya, Malawi, Mauritius, Mozambique, Seychelles, South Africa, Sudan, Uganda, the United Republic of Tanzania, Zambia or Zimbabwe. Most (92%) of the studies included in the meta-analysis employed probability- or census-sampling techniques and had response rates of 62–99%. Sex-specific prevalences of diabetes mellitus, impaired fasting glycaemia and impaired glucose tolerance were included in the reports of 35, 21 and 11 of the studies, respectively. Almost half (45%) of the studies were conducted in both urban and rural areas. The other studies were conducted exclusively in urban (26%), rural (23%) or periurban (6%) areas. In terms of quality, the studies were categorized as either "positive" ($n = 31$) or "neutral" ($n = 5$)[42,49,58,61,63] (Appendix A, available at: http://www.med.nagoya-u.ac.jp/intnl-h/swfu/d/auto-UZzMJC.pdf).

Sex-specific prevalences

The prevalence of diabetes mellitus was 5.7% (95% CI: 4.8–6.8) overall, with a slight difference between the men (5.5%; 95% CI: 4.1–7.2) and women (5.9%; 95% CI: 4.6–7.6) included in the meta-analysis. The prevalence of impaired fasting glycaemia was 4.5% (95% CI: 3.3–6.1) overall – 5.7% (95% CI: 3.7–8.6) among the men and 3.5% (95% CI: 2.1–5.8) among the women – whereas the prevalence of impaired glucose tolerance was 7.9% (95% CI: 6.7–9.2) overall – 7.3% (95% CI: 6.0–8.8) among the men and 8.5% (95% CI: 6.7–10.7) among the women.

Odds ratios

The prevalence of diabetes mellitus among men was not significantly different from that among women (OR: 1.01; 95% CI: 0.91–1.11). However, impaired fasting glycaemia appeared to be significantly more common among men than among women (OR: 1.56; 95% CI: 1.20–2.03), whereas impaired glucose tolerance appeared to be significantly less common among men than among women (OR: 0.84; 95% CI: 0.72–0.98) (Fig. 2). These significant differences between the sexes were still observed when the analysis was restricted to those studies in which the prevalences of both impaired fasting glycaemia and impaired glucose tolerance were