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Original Research

Nutritional dual burden in Indigenous young adults: The geographical differential

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Abstract

Objective: *Nutritional dual burden is defined as the coexistence of underweight and overweight in the same population. We report the rates of nutritional dual burden in Indigenous young men and women in the Northern Territory. Additionally, we examine the impact geographical area has on these rates.*

Design: *Cross-sectional data obtained from the longitudinal Aboriginal Birth Cohort Study.*

Setting: *Participants residing in over 40 urban and remote communities across the Top End of the Northern Territory.*

Participants: *Young adults aged 23–28 years; urban (*n = *99) and remote (*n = *316).*

Main outcome measure(s): *Anthropometric data was directly collected using standardised methods. Underweight was defined as BMI ≤ 18.5 kg/m^2 and overweight/obese as body mass index ≥ 25 kg/m^2. Remote residency was categorised by established shires/regions (Vic/Daly, Arnhem and Tiwi).*

Results: *Significantly higher levels of underweight were seen in remote participants, compared to urban participants, irrespective of sex. Further differences were seen by regions, with the highest rates seen in Vic/Daly, compared to Arnhem and Tiwi. Higher rates of overweight/obesity were found in urban participants, compared to remote. The levels of overweight/obesity varied, depending on region of residence.*

Conclusion: *Underweight and overweight patterns coexist in Indigenous young adults, with variation across geographical regions. Health programs need to take this dual nutritional burden into consideration to avoid worsening the severity of underweight, whilst reducing levels of overweight.*

KEY WORDS: *health, indigenous, overweight, remote, underweight.*

Introduction

Obesity is a global health problem, with more than 650 million adults affected.[1] In Australia, over 4.9 million adults (28%) are obese, with a further 6.3 million (35%) being overweight.[2] Higher rates are reported in Indigenous adults (43%, compared with 27% for non-Indigenous adults).[3] Obesity is strongly associated with several chronic diseases, including diabetes, cardiovascular disease, hypertension and mental health.[1] However, in developing countries and transitional societies, this increase in obesity occurs concurrently with persisting underweight.[4] This coexistence of undernutrition and overnutrition is described as 'nutritional dual burden'.[4]

Underweight predisposes an individual to disease, particularly infectious disease, delays recovery from illness and detrimentally affects physical and psychological health.[5] The affect can be seen into the next generation, with underweight women of child-bearing age at an increased risk of pregnancy complications and giving birth to low-birthweight (LBW) babies.[6] Babies born LBW, have an increased risk of developing chronic diseases, such as diabetes, hypertension and cardiovascular disease, in later life.[7,8] This risk is magnified in those LBW babies who later become obese.

Indigenous Australians represent 2.8% of the Australian population, with ~35% residing in major Australian cities (where they constitute ~1% of the population).[3] There are ~500 Indigenous clan groups, each having a distinctive culture, belief and language. The Northern Territory (NT) has the highest proportion of Indigenous persons (25.5%), of whom four out of five reside in remote or very remote areas.[9] Australia's rural and remote populations tend to have

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***What is already known on this subject*:**
- *Indigenous Australians have high rates of chronic diseases contributing to their premature mortality.*
- *Obesity has traditionally been the focus of health campaigns in Australia.*
- *Underweight predisposes an individual to disease and increases risk of pregnancy complications.*

***What this study adds*:**
- *Dual burden of underweight and overweight is present in Northern Territory Indigenous young adults.*
- *Despite the high rates of underweight, the focus is predominantly on obesity in adults.*
- *Both underweight and obesity need to be addressed to improve health outcomes.*

higher mortality rates and consequently lower life expectancy. A life expectancy gap of 7 years is evident between people residing in remote areas and those in urban areas of the NT.[10] This might, in part, be related to limited access to fresh food, health care, education and employment opportunities affecting those residing remotely.[11]

Indigenous Australians have been described as a population in nutrition transition.[11] Traditional diets, high in complex carbohydrates and fibre, are being replaced with convenience diets high in fats and sweeteners. The disease burden, which was mainly related to underweight, is changing to the chronic diseases of obesity.[11] Chronic diseases occur on average 15–20 years earlier in Indigenous Australians than in non-Indigenous Australians, contributing to the premature mortality seen in Indigenous Australians.[12]

While the presence of high levels of underweight in Indigenous Australian children has been reported,[11,13,14] there is a scarcity of information on young adults. The aims of this study were twofold: (i) to report the rates of underweight and overweight in Indigenous young men and women in the NT; and (ii) to examine the impact that geographical area has on rates.

Methods

The Aboriginal Birth Cohort (ABC) is a prospective longitudinal study examining the effect of early life factors on later health and burden of disease. Based in the NT, it is the longest running and largest Indigenous birth cohort in Australia and one of the few in the world focusing on Indigenous populations in English-speaking countries.[15]

Cross-sectional data is presented from the fourth follow-up, between September 2013 and June 2015, with participants aged 23–28 years. The recruitment of the ABC has been described elsewhere.[16] In brief, between January 1987 and March 1990, 686 babies born to Indigenous mothers (a representative sample of the 1238 eligible babies) at Royal Darwin Hospital were recruited.[16] This hospital covers an area encompassing 400 000 km^2 across the 'Top End' of the NT, and at the time, 90% of pregnant Indigenous mothers delivering their babies there.[17]

Setting

Participants resided in over 40 urban and remote communities across the NT. Approximately 74% resided in remote and very remote (hereafter, called 'remote') communities and the remainder in urban Darwin and its immediate surrounds. Remote communities vary in population size, from 200 to 2200 people, with many small family groups living in outstations (<50 people). In this cohort of young adults, 19% ($n = 75$) reported having lived in another community. However, minimal movement was seen between urban and remote settings (19 remote participants previously lived in urban settings and 12 urban previously lived remotely).

Procedures

Body size and shape were measured by a trained researcher using standardised techniques outlined below. Participants were measured in light clothing and barefoot. Height was measured to the nearest millimetre using a calibrated, portable wall-mounted stadiometer. Weight and body composition were measured to the last complete 0.1 kg with a digital electronic scale (TBF-521; Tanita Corporation, Arlington Heights, Illinios, USA).

Flexible tapes were used to measure body size to the nearest millimetre. Standardised measurements were taken: mid-upper arm circumference (MUAC) at the mid-point between the acromion process of scapula and the olecranon process; waist circumference in a horizontal plane, midway between the lowest ribs and the iliac crests; and hip circumference at the widest level over the greater trochanters.

Ethics approval

The ABC study was approved by the Human Research Ethics Committee of the Northern Territory

Department of Health and Families and the Menzies School of Health Research, which includes the Aboriginal Ethical Sub-committee which has the power of veto.

Statistical analysis

STATA 14.2 (StataCorp, College Station, Texas, USA) statistical package was used for analysis. Continuous variables were analysed by ANOVA, with Pearson's χ^2 tests used for categorical variables. Response rates were examined by area of residency and sex.

Area of residence was classified as 'remote' and 'urban'. Analysis was restricted to those residing in the 'Top End' with remote residence further classified by established shires/regions: Vic/Daly, Arnhem and Tiwi. Figure 1 depicts the geographical boundaries and communities involved. In this study, pregnant women were excluded (remote $n = 14$; urban $n = 8$). A further three people were excluded as both height and weight were not obtained (one urban man and two remote women). Height/weight^2 (cm kg^{-2}) was used to calculate BMI and categorized as underweight (<18.5), normal (18.5–24.9), overweight (25–29.9) and obese (≥30).[18]

Results

Of the 459 ABC participants seen in this follow-up, 397 met the above criteria. The mean age was 25.3 years (23–28). Men accounted for 47% remote participants and 57% urban. Of the 317 remote participants, 107 lived in Vic/Daly, 159 in Arnhem and 51 in Tiwi. There were 80 urban participants. No difference in body size was seen between those who had lived remote or urban their whole life and those who had not.

Urban remote difference

Significant differences in all measures of body size were seen in remote, compared to urban, participants (Table 1). Lower BMI was seen in remote, compared to urban, participants, irrespective of sex ($P < 0.005$). These trends were reflected in all other markers of body size. Remote participants were significantly

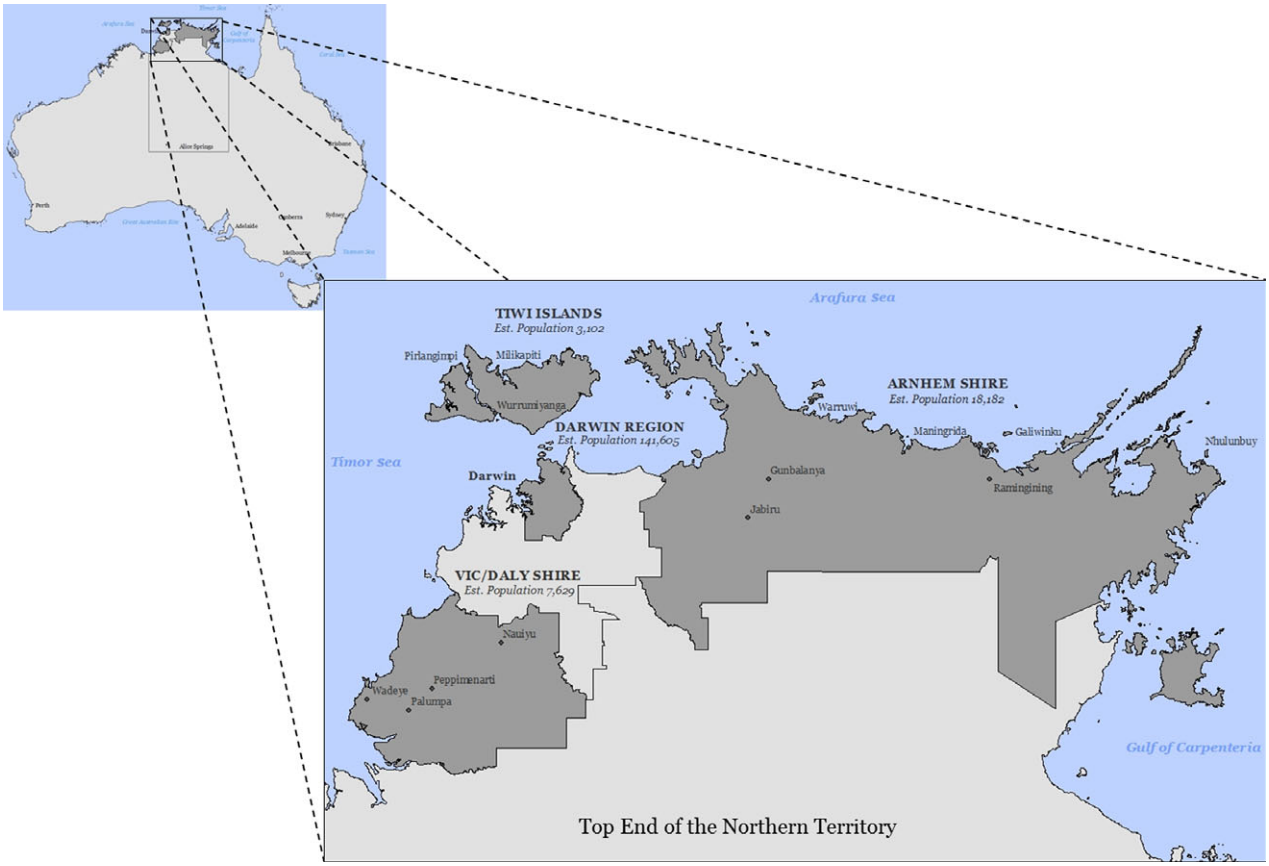

FIGURE 1: *Geographical boundaries used, communities included and population estimates of Northern Territory shires/regions.*

TABLE 1: *Anthropometric measurements for urban and remote Indigenous adults by sex*

Measurement	Urban	Remote	*P*
All	*n* = 80	*n* = 317	
Age in years	26.0 (25.0–26.0)	25.0 (24.0–26.0)	0.013
Height	171.1 (163.7–178.0)	166.3 (160.4–172.8)	<0.001
Weight	75.9 (64.–88.2)	61.8 (50.8–72.8)	<0.001
Waist	92.0 (84.0–103.3)	82.0 (72.5–94.0)	<0.001
Hip	101.5 (92.4–109.9)	92.0 (85.0–101.0)	<0.001
MUAC	30.6 (27.9–35.3)	27.4 (24.5–30.5)	<0.001
Waist/height ratio	0.53 (0.49–0.62)	0.49 (0.43–0.57)	<0.001
Waist/hip ratio	0.92 (0.89–0.97)	0.89 (0.84–0.94)	<0.001
BMI	25.6 (22.1–30.5)	21.7 (18.3–26.6)	<0.001
BMI categories: % (*n*)			<0.001
Underweight	6.3 (5)	25.9 (82)	
Normal	41.3 (33)	42.0 (133)	
Overweight	27.5 (22)	21.5 (68)	
Obese	25.0 (20)	10.7 (34)	
Men	*n* = 43	*n* = 149	
Age in years	26.0 (25.0–26.0)	25.0 (25.0–26.0)	0.054
Height	177.3 (171.4–183.5)	172.9 (168.9–178.0)	0.002
Weight	82.0 (70.4–97.2)	63.6 (54.8–75.4)	<0.001
Waist	92.0 (85.0–103.5)	80.0 (72.2–89.2)	<0.001
Hip	100.0 (94.0–107.6)	89.8 (84.0–97.0)	<0.001
MUAC	33.0 (30.0–36.9)	28.5 (26.0–31.9)	<0.001
Waist/height ratio	0.53 (0.49–0.60)	0.46 (0.42–0.51)	<0.001
Waist/hip ratio	0.94 (0.90–0.99)	0.89 (0.85–0.92)	<0.001
BMI	26.3 (23.1–31.2)	21.1 (18.6–25.0)	<0.001
BMI categories: % (*n*)			<0.001
Underweight	2.3 (1)	23.5 (35)	
Normal	39.5 (17)	51.7 (77)	
Overweight	32.6 (14)	16.8 (25)	
Obese	25.6 (11)	8.1 (12)	
Women†	*n* = 37	*n* = 168	
Age in years	25.0 (25.0–26.0)	25.0 (24.0–26.0)	0.15
Height	163.5 (160.5–168.0)	160.9 (157.8–164.5)	0.014
Weight	67.3 (57.1–80.0)	57.8 (46.9–71.2)	0.005
Waist	93.0 (81.0–103.0)	85.8 (73.0–98.0)	0.016
Hip	103.0 (88.7–111.0)	95.75 (86.0–105.0)	0.025
MUAC	29.4 (26.4–33.5)	26.5 (23.2–29.5)	<0.001
Waist/height ratio	0.55 (0.49–0.64)	0.53 (0.46–0.61)	0.066
Waist/hip ratio	0.91 (0.85–0.95)	0.89 (0.84–0.94)	0.22
BMI	24.2 (20.4–29.8)	22.6 (17.9–27.2)	0.034
BMI categories: % (*n*)			0.077
Underweight	10.8 (4)	28.0 (47)	
Normal	43.2 (16)	33.3 (56)	
Overweight	21.6 (8)	25.6 (43)	
Obese	24.3 (9)	13.1 (22)	

Note: median (interquartile range) presented for continuous variables and percentage (number) for categorical.
†Non-pregnant women. BMI, body mass index; BMI categories: underweight <18.5, normal 18.5–24.9, overweight 25–29.9, obese ≥30; MUAC, mid-upper arm circumference.

shorter, weighed less and had smaller MUAC, waist and hip circumferences ($P < 0.005$ for all markers). They also had lower waist-to-height ratios and waist-to-hip ratios.

Underweight rates were significantly greater in remote (26%), compared to urban, participants (6%), irrespective of sex. The highest rates of underweight were in remote-residing women (28%). Higher rates of overweight/obesity were seen in urban (53%), compared to remote (32%) participants. Significantly higher rates of overweight/obesity were seen in remote women (39%), compared to remote men (25%) ($P = 0.01$) (Table 1).

Geographical differences in remote participants

Further differences in body size were seen in remote participants between shires. Those in Vic/Daly shire had the lowest median BMI, followed by Arnhem and Tiwi, irrespective of sex, as shown in Figure 2. This trend was reflected in weight, as well as waist and hip circumferences (Table 2). However, the Vic/Daly men and women were taller than their remote counterparts, but similar to their urban counterparts.

The highest rates of underweight were seen in those residing in Vic/Daly for both men (39%) and women (38%). Women had higher rates of underweight than men in both Arnhem (24% and 19%, respectively) and Tiwi (21% and 4%, respectively). Lower levels of overweight/obesity were seen in men in Vic/Daly and Arnhem, compared to women (16% versus 30% and 26% versus 45%, respectively), with similar rates in Tiwi (39% and 36%, respectively). Despite having the lowest level of overweight/obesity, men in Vic/Daly had higher rates of obesity than overweight (12% versus 4%). However, the numbers are small (Fig. 3).

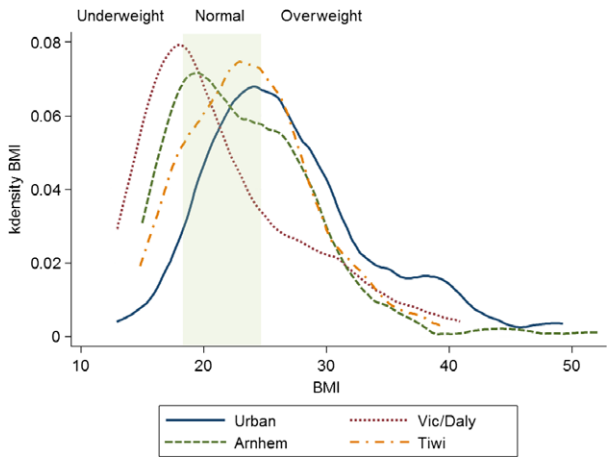

FIGURE 2: *Distribution of body mass index (BMI) in each shire (kernel density estimates).*

Discussion

The dual burden of underweight and overweight exists in Indigenous young adults in the NT. One-in-three young adults were classified as overweight or obese, while one-in-five remained underweight. This dual burden was particularly evident in remote-residing women, where one-in-three was overweight or obese, coupled with one-quarter being underweight.

We believe this pattern represents a continuing prevalence of underweight with a concurrent rise in overweight/obesity at this age. Similarly, high rates of childhood undernutrition are still present, but increasing rates of overweight are being reported across the Top End even in the youngest children.[19] Possible explanations exist for the differences seen between remote and urban participants including the availability, cost and range of food, access to traditional foods and lower levels of employment (26% versus 42%, respectively).[11] Food insecurity is more common in remote-residing Indigenous persons, with 31% living in a household that had run out of food and could not afford to buy more.[20]

The differences within remote areas are more difficult to explain. While access to commercial fresh food is restricted and costly, this is similar across the regions.[11,20] All the Tiwi live in coastal regions, as do two-thirds of Vic/Daly and Arnhem participants and all have similar access to traditional foods. The access to food and services, although varying slightly, is similar for communities across the region; therefore differences in food systems, pace of nutrition and socioeconomic transition are unlikely to explain these differences.

Although the nationally reported rate of underweight (2–5%) is highest in Indigenous adults aged 18–34 years, it is still significantly lower than the rates seen in this cohort.[3] Limited information is available for adults in the NT, with the National Health Survey reporting underweight and normal weight together.[10] Wang and Hoy reported that the distribution of BMI in 2001 in one remote Indigenous community of the NT differed from the general population, with fewer overweight and more underweight residents.[21]

Of particular concern are the high rates of underweight seen in remote-residing women. Although varying greatly by geographical area, the rates seen in this cohort are similar to those reported in developing countries, such as Bangladesh, India and Vietnam.[22–24] Maternal underweight impacts not only the woman and her baby's health, but also that of subsequent

TABLE 2: *Anthropometric measurements for remote Indigenous adults by shire and sex*

Measurement	Vic/Daly	Arnhem	Tiwi	*P*
All	*n* = 107	*n* = 159	*n* = 51	
Age in years	25.0 (24.0–26.0)	25.0 (25.0–26.0)	25.0 (24.0–26.0)	0.85
Height	170.0 (161.4–176.8)	164.4 (160.2–173.3)	166.3 (160.0–169.9)	0.007
Weight	56.2 (48.0–71.4)	62.4 (52.0–72.8)	66.2 (54.6–74.8)	0.065
Waist	76.2 (68.5–87.1)	84.3 (73.5–95.5)	87.3 (76.6–98.9)	<0.001
Hip	88.0 (83.4–96.0)	93.4 (86.0–102.3)	97.0 (88.8–101.5)	0.003
MUAC	26.0 (23.3–31.0)	27.6 (25.5–30.3)	28.0 (24.8–29.8)	0.15
Waist/height ratio	0.46 (0.40–0.54)	0.50 (0.45–0.58)	0.53 (0.45–0.61)	<0.001
Waist/hip ratio	0.87 (0.82–0.92)	0.89 (0.85–0.94)	0.90 (0.87–0.95)	0.009
BMI	19.5 (16.7–24.9)	22.4 (18.7–26.9)	24.0 (19.7–26.9)	0.002
Men	*n* = 51	*n* = 75	*n* = 23	
Height	176.8 (172.6–179.7)	171.5 (167.5–175.6)	169.9 (167.4–177.1)	<0.001
Weight	59.4 (52.8–75.6)	63.8 (54.8–75.6)	66.6 (61.2–75.4)	0.27
Waist	74.3 (68.3–86.0)	80.0 (73.1–90.4)	85.5 (76.6–95.3)	0.008
Hip	87.0 (82.8–94.6)	90.2 (84.0–97.5)	92.1 (87.5–97.5)	0.080
MUAC	27.6 (25.3–31.4)	28.8 (26.1–32.0)	29.5 (27.3–31.5)	0.31
Waist/height ratio	0.42 (0.39–0.48)	0.46 (0.43–0.52)	0.49 (0.44–0.57)	<0.001
Waist/hip ratio	0.87 (0.82–0.92)	0.89 (0.86–0.93)	0.90 (0.87–0.95)	0.090
BMI	19.5 (17.1–23.9)	21.4 (19.0–25.6)	23.0 (19.9–26.1)	0.021
Women†	*n* = 56	*n* = 84	*n* = 28	
Height	161.8 (158.9–165.8)	160.7 (157.1–163.5)	160.2 (157.0–166.1)	0.20
Weight	50.8 (43.9–70.7)	61.7 (48.9–71.2)	63.4 (51.3–74.2)	0.13
Waist	78.4 (68.9–90.0)	87.0 (76.0–98.5)	89.2 (75.5–103.3)	0.010
Hip	89.5 (84.8–101.0)	97.5 (87.5–105.0)	99.1 (91–109.0)	0.033
MUAC	24.9 (21.8–30.8)	27.0 (23.5–29.5)	26.5 (24.1–28.3)	0.30
Waist/height ratio	0.48 (0.42–0.56)	0.55 (0.46–0.62)	0.55 (0.47–0.63)	0.008
Waist/hip ratio	0.87 (0.83–0.92)	0.90 (0.84–0.96)	0.90 (0.86–0.95)	0.061
BMI	19.8 (16.2–27.0)	24.1 (18.6–27.5)	24.2 (19.0–27.3)	0.058

Note: median (interquartile range) is presented.

†Non-pregnant women. BMI, body mass index; BMI categories: underweight <18.5, normal 18.5–24.9, overweight 25–29.9, obese ≥30; MUAC, mid-upper arm circumference.

generations. Maternal malnutrition needs to be addressed in order to break the cycle of child undernutrition and adulthood underweight and overweight, as well as the related chronic diseases.

The nutritional transition from underweight to obesity is evident in this cohort, particularly in urban residents. Diets are becoming energy-dense but nutrient-poor, physical activity levels are decreasing and sedentary lifestyles are predominating.[11] Overweight/obesity rates in young adulthood are higher in Indigenous Australians (women 59% and men 51%) than non-Indigenous Australians (women 31% and men 41%).[2, 3] Overweight/obesity in this cohort was similar to the national rate (54%), with the highest rates in urban-residing participants.

The main limitation of this study is the relatively small participant numbers that might have reduced the power to detect small associations. However, a number of significant associations were seen. A major strength of this study is the ongoing nature which follows the life course approach. The ability to add to the already-collected data increases both depth and breadth to this unique resource, enhancing its value now, into the future and into the next generations.

Conclusion

Obesity, as opposed to undernutrition, has traditionally been the focus of health campaigns in Australia. Rising obesity rates are of concern; however, underweight rates remain high in some populations and are being overlooked. Alarmingly high rates of underweight were seen in some geographic areas of the NT, particularly concerning in women of child-bearing age. The dual burden of underweight and overweight in remote Indigenous Australians needs to be recognised. Health programs

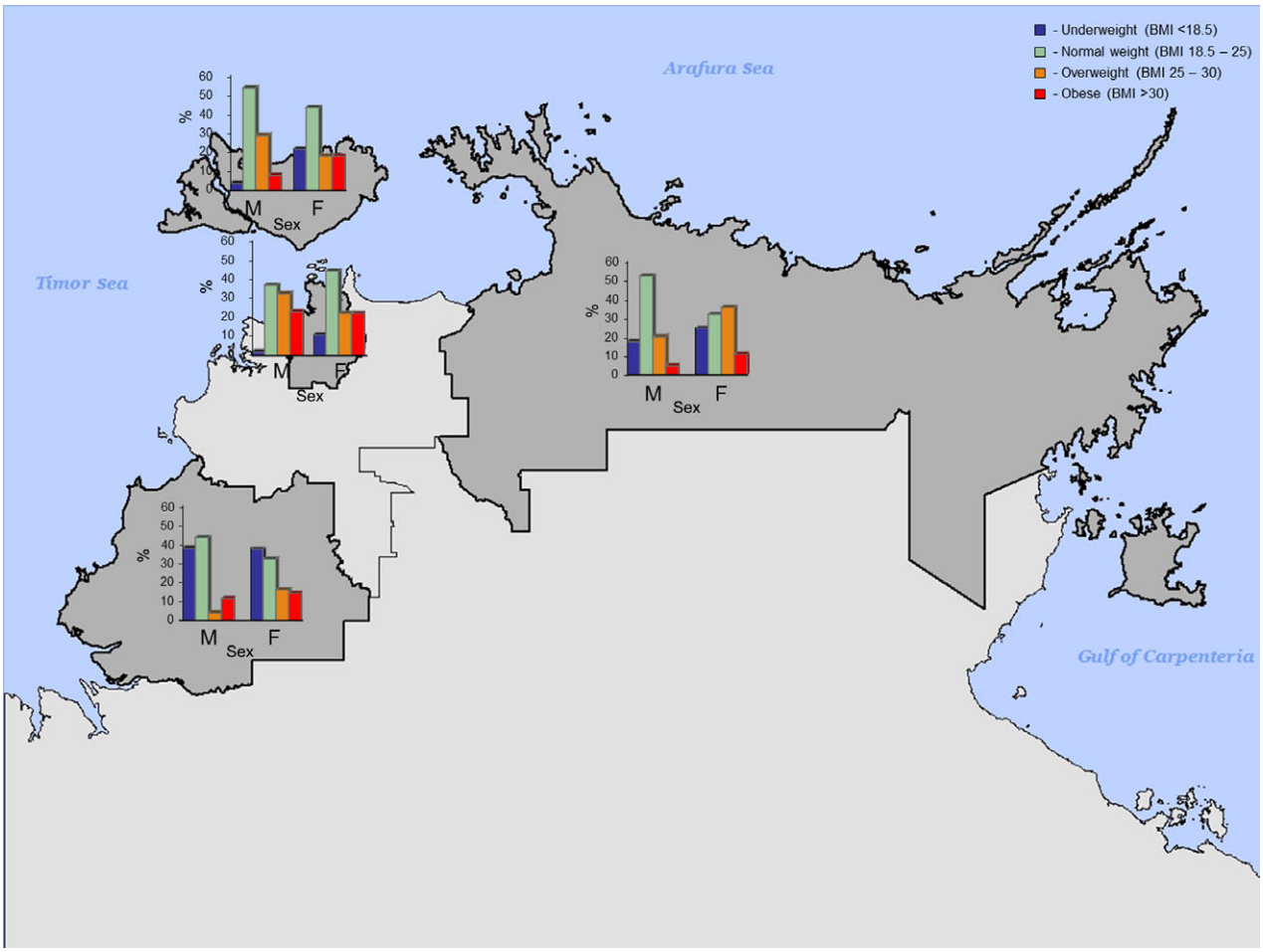

FIGURE 3: *Distribution of body mass index (BMI) categories for men and women by shire (right represents men; left represents women).*

need to take this dual nutritional burden into consideration to avoid worsening the severity of underweight, whilst reducing levels of overweight.

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Author's contribution

All authors have made a substantial contribution to drafting and critical revision of the manuscript for important intellectual content. BD was responsible methodology design, supervised the field methods, analysed and interpreted the data and drafted the manuscript (60%). JF, KMQ and SW (5% each) obtained the data and provided critical revision. TH assisted with data analysis and provided critical revision (5%). GS was responsible for conception and design of the project, supervised the field methods and provided critical revision (20%).

Disclosure statement

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