Public Health Nutrition: 15(11), 2118–2123 doi:10.1017/S1368980011003491

Short communication
BMI among Timorese aged ≥40 years

Jacqueline Ramke[1,*] and Garry Brian[1,2,3]
[1]The Fred Hollows Foundation New Zealand, Private Bag 99909, Newmarket, Auckland 1023, New Zealand: [2]Dunedin School of Medicine, University of Otago, Dunedin, New Zealand: [3]Population Health Eye Research Network, Brisbane, Australia

Submitted 25 May 2011: Accepted 8 December 2011: First published online 11 January 2012

Abstract

Objective: To determine the distribution and sociodemographic associations of BMI (kg/m^2) among adults aged ≥40 years living in Timor-Leste.
Design: BMI was calculated for participants of a population-based cross-sectional survey.
Setting: Urban and rural Timor-Leste.
Subjects: Adults aged ≥40 years living in Timor-Leste.
Results: Of those enumerated, 2014 participated (89·5 %). Male gender, rural domicile, older age, illiteracy and source of household income were associated with BMI < 18·5 kg/m^2 on multivariate analysis. Female gender, urban domicile and literacy were associated with BMI ≥25·0 and ≥30·0 kg/m^2. Adjusting for gender, age and domicile, and extrapolating to those aged ≥40 years across Timor-Leste, 9·9 %, 36·0 %, 6·6 % and 0·8 % had BMI <16·0, <18·5, ≥25·0 and ≥30·0 kg/m^2, respectively.
Conclusions: At this time, being 'underweight' or 'severely thin' is more prevalent in the Timorese adult population than being 'overweight' or 'obese'.

Keywords
BMI
Timor-Leste

The WHO has recognized the link between changing diets and lifestyle ('nutritional transition'), increasing obesity and increased risk of a range of diseases including CVD, hypertension, diabetes mellitus and hyperlipidaemia[1,2]. It has also identified that many developing countries have the double burden of this increasing overnutrition while concurrently still attempting to address undernutrition within their populations[1].

Timor-Leste is a relatively new nation of 1·1 million people, approximately 80 % of whom currently live in rural areas and half of whom lived below the poverty line (<$US 0·88/d) in 2007[3].

Geographically positioned at the eastern end of the Indonesian archipelago near the island of New Guinea, ethnically the majority of Timorese are of Austronesian (Malayo-Polynesian) or Melanesian-Papuan origin.

The health status of the population is generally poor. There is high morbidity from infectious disease, and maternal and child health indicators, including malnutrition, are problematic[4]. Food security is also an issue: 29 % of farmers reported insufficient maize harvest to meet their annual need in 2009[5] and Timor-Leste has the worst Global Hunger Index in South-East Asia[6].

To date, 'lifestyle diseases' associated with obesity have not been identified as a priority by the Ministry of Health in Timor-Leste and population-based prevalence estimates are as yet unavailable. Obtaining more information about the body fat profile of the Timorese population will assist in understanding the current situation relating to over- and undernutrition and planning for the most appropriate allocation of resources in the future.

A Demographic and Health Survey in 2003 reported a mean BMI of 19·5 kg/m^2 for women aged 15–49 years and 19·7 kg/m^2 for men aged 15–54 years[7]. When measurement was repeated for the female group in the 2010 Demographic and Health Survey[4], mean BMI had increased to 20·2 kg/m^2. Neither of these surveys reported sociodemographic risk factors for high or low BMI.

The Timor-Leste Eye Health Survey 2010 estimated the prevalence and causes of vision impairment and blindness for adults aged ≥40 years in Timor-Leste. The present paper reports BMI data from that survey, using the WHO classification of underweight (BMI < 18·5 kg/m^2), normal weight (BMI = 18·5–24·9 kg/m^2), overweight (BMI ≥ 25·0 kg/m^2) and obese (BMI ≥ 30·0 kg/m^2) for adults[8]. Severe thinness (BMI < 16·0 kg/m^2)[9] and BMI cut-off points suggested to assist comparison with other populations[10] are also presented.

Methods

The survey took place between August 2009 and May 2010, with a 4-month break for the monsoon season, which made some roads impassable.

*Corresponding author: Email jramke@gmail.com

Sampling plan

The sample frame of the eye health survey included all people aged ≥40 years living in Timor-Leste's twelve mainland districts (173 000 people; 87·2 % rural dwellers). Using an anticipated prevalence of blindness (presenting visual acuity worse than 6/60 in both eyes) of 7·5 % in the target population, absolute precision of ±1·5 % (20 % relative difference), with 95 % confidence, a design effect of 1·6 and a response rate of 80 %, the sample size was determined to be 2250 persons. From the sample frame, fifty clusters of forty-five people were required. Across the twelve districts, the clusters were selected through probability proportionate to size sampling, using 2004 census data.

Pilot

A pilot study was undertaken (sixty participants from three clusters, representative of the population to be enumerated in the main survey) to refine and validate the questionnaire and to standardize and streamline the examination. These data were not included in the final survey analysis.

Enumeration

Using a random process, the team leader identified the first household to be targeted in each cluster. Thereafter, consecutive households were approached and eligible people enumerated by trained local fieldworkers until the forty-five participants for that cluster were enrolled.

Enumerated residents amenable to participating attended a central facility, typically a community hall, for administration of a questionnaire and examination.

Questionnaire and clinical examination

An interview-based questionnaire, developed in English, translated into Tetun (the local language) and back translated to ensure veracity, was used to collect data.

Participants were asked to provide demographic, socioeconomic and health-related information. Participants' barefoot stretch stature height was measured to the nearest centimetre using a portable stadiometer. Weight, with the participant in light tropical clothing and without shoes, was measured to the nearest 0·1 kg using portable scales.

Data analysis

Data were de-identified and entered into a specifically designed database during the survey, with subsequent random checking of up to 20 % of records for entry integrity. BMI was calculated for each participant. Analysis involved univariate comparisons of the prevalence of BMI $<16{\cdot}0$, $<18{\cdot}5$, $\geq 25{\cdot}0$ and $\geq 30{\cdot}0\,kg/m^2$ by key sociodemographic variables, followed by multivariate logistic regression to estimate relative differences in risk between sociodemographic groups. This was performed using PASW/SPSS Statistics 18·0 (SPSS Inc., Chicago, IL, USA). Statistical significance was accepted at $P<0{\cdot}05$.

National census data (2004) were used to adjust the sample prevalence estimates for gender, age and domicile and to extrapolate the findings to those aged ≥40 years across the entire country.

Ethical considerations

The Timor-Leste Ministry of Health ethics apparatus, the precursor of the subsequently formed National Research Ethics Review Committee, approved the study and its methodology. The tenets of the Declaration of Helsinki were observed.

Consent was obtained from village chiefs prior to survey commencement in each cluster and participants provided written acknowledgement of informed consent prior to enrolment. Referral to permanent health-care services was organized for any participant requiring refraction or ocular investigation or treatment.

Results

Of the 2250 eligible people enumerated, 2014 participated (89·5 %). Height and/or weight measurements were not recorded for eleven people; therefore data are reported for 2003 participants.

The mean height for males (*n* 1039) and females (*n* 964) was 1·61 (SD 0·07) m and 1·50 (SD 0·07) m, respectively. Mean weight was 50·3 (SD 8·3) kg and 45·0 (SD 9·2) kg, respectively.

The mean BMI of the sample was 19·6 (SD 3·3) kg/m^2 (range 11·1–39·2 kg/m^2; Fig. 1): 19·3 (SD 2·8) kg/m^2 (range 12·2–34·9 kg/m^2) for males and 19·9 (SD 3·8) kg/m^2 (range 11·1–39·2 kg/m^2) for females (Table 1).

Of males, 39·3 % had BMI $<18{\cdot}5\,kg/m^2$ and 9·8 % had BMI $<16{\cdot}0\,kg/m^2$, while 3·1 % had BMI $\geq 25{\cdot}0\,kg/m^2$ and

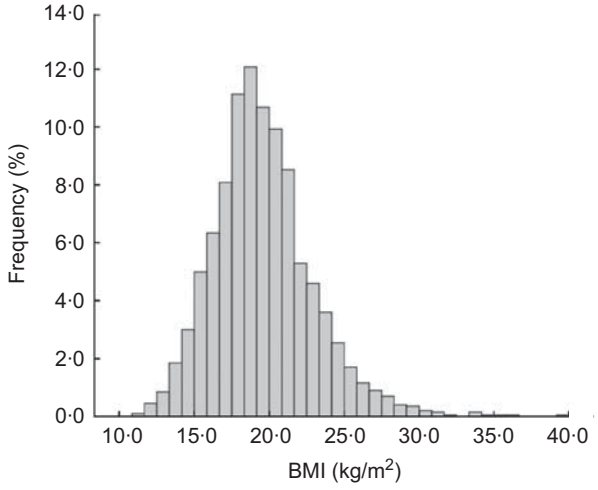

Fig. 1 Distribution of BMI (mean 19·6 (SD 3·3) kg/m^2) among adults (*n* 2003) aged ≥40 years, Timor-Leste, 2010

Table 1 Mean BMI and BMI distribution according to demographic and socio-economic characteristics of adults (*n* 2003) aged ≥40 years, Timor-Leste, 2010

			BMI (kg/m^2)																							
	Total				<16·0		<18·5		≥18·5–22·9		≥18·5–24·9		≥23·0		≥25·0		≥27·5		≥30·0		≥32·5		≥35·0		≥37·5		≥40·0	
Characteristic	*n*	%	Mean	SD	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Gender																												
Male	1039	51·9	19·3	2·8	102	9·8	408	39·3	531	51·1	599	57·7	100	9·6	32	3·1	8	0·8	4	0·4	2	0·2	–	–	–	–	–	–
Female	964	48·1	19·9	3·8	125	13·0	361	37·4	423	43·9	511	53·0	180	18·7	92	9·5	36	3·7	12	1·2	5	0·5	3	0·3	1	0·1	–	–
Age (years)																												
40–49	686	34·2	20·5	3·4	32	4·7	181	26·4	366	53·4	442	64·4	139	20·3	63	9·2	25	3·6	9	1·3	4	0·6	3	0·4	1	0·1	–	–
50–59	486	24·3	19·9	3·2	43	8·8	167	34·4	239	49·2	287	59·1	80	16·5	32	6·6	10	2·1	3	0·6	2	0·4	–	–	–	–	–	–
60–69	541	27·0	18·8	3·2	95	17·6	260	48·1	236	43·6	260	48·1	45	8·3	21	3·9	8	1·5	4	0·7	1	0·2	–	–	–	–	–	–
≥70	290	14·5	18·3	2·9	57	19·7	161	55·5	113	39·0	121	41·7	16	5·5	8	2·8	1	0·3	–	–	–	–	–	–	–	–	–	–
Domicile																												
Urban	280	14·0	21·2	4·0	16	5·7	70	25·0	130	46·4	164	58·6	80	28·6	46	16·4	18	6·4	10	3·6	4	1·4	2	0·7	–	–	–	–
Rural	1723	86·0	19·3	3·1	211	12·2	699	40·6	824	47·8	946	54·9	200	11·6	78	4·5	26	1·5	6	0·3	3	0·2	1	0·1	1	0·1	–	–
Literacy																												
Literate	676	33·7	20·8	3·4	25	3·7	160	23·7	364	53·8	445	65·8	152	22·5	71	10·5	30	4·4	13	1·9	5	0·7	3	0·4	1	0·1	–	–
Illiterate	1327	66·3	19·0	3·1	202	15·2	609	45·9	590	44·5	665	50·1	128	9·6	53	4·0	14	1·1	3	0·2	2	0·2	–	–	–	–	–	–
Main source of household income†																												
Unemployed	897	44·8	19·6	3·5	120	13·4	358	39·9	407	45·4	475	53·0	132	14·7	64	7·1	24	2·7	10	1·1	4	0·4	1	0·1	–	–	–	–
Farming	843	42·1	19·1	2·8	93	11·0	364	43·2	401	47·6	455	54·0	78	9·3	24	2·8	9	1·1	1	0·1	1	0·1	–	–	–	–	–	–
Paid	242	12·1	21·3	3·5	10	4·1	39	16·1	134	55·4	168	69·4	69	28·5	35	14·5	10	4·1	5	2·1	2	0·8	2	0·8	1	0·4	–	–
Total	2003	100·0	19·6	3·3	227	11·3	769	38·4	954	47·6	1110	55·4	280	14·0	124	6·2	44	2·2	16	0·8	7	0·3	3	0·1	1	0·0	–	–

†21 unknowns.

Table 2 Association of being severely thin, underweight, overweight and obese with demographic and socio-economic characteristics of adults (*n* 2003) aged ≥40 years, Timor-Leste, 2010

		Severely thin (BMI < 16·0 kg/m²)						Underweight (BMI < 18·5 kg/m²)						Overweight (BMI ≥ 25·0 kg/m²)						Obese (BMI ≥ 30·0 kg/m²)					
		Univariate			Multivariate			Univariate			Multivariate			Univariate			Multivariate			Univariate			Multivariate		
Characteristic	*n*	OR	95 % CI	*P* value	OR†	95 % CI	*P* value	OR	95 % CI	*P* value	OR†	95 % CI	*P* value	OR	95 % CI	*P* value	OR†	95 % CI	*P* value	OR	95 % CI	*P* value	OR†	95 % CI	*P* value
Gender																									
Male	1039	1·0	Ref.		1·0	Ref.		1·1	0·9, 1·3	0·408	1·2	1·0, 1·5	0·036*	1·0	Ref.		1·0	Ref.		1·0	Ref.		1·0	Ref.	
Female	964	1·4	1·0, 1·8	0·029*	1·2	0·9, 1·6	0·213	1·0	Ref.		1·0	Ref.		3·3	2·1, 5·0	<0·001***	4·8	3·0, 7·7	<0·001***	4·5	1·0, 8·9	0·068	4·5	1·3, 14·9	0·015*
Domicile																									
Urban	280	1·0	Ref.		1·0	Ref.		1·0	Ref.		1·0	Ref.		4·3	2·9, 6·3	<0·001***	2·9	1·8, 4·5	<0·001***	9·5	3·5, 25·8	<0·001***	5·1	1·7, 15·7	0·004**
Rural	1723	2·3	1·4, 3·9	0·001**	2·0	1·1, 3·5	0·015*	2·0	1·5, 2·7	<0·001***	1·6	1·2, 2·3	0·002**	1·0	Ref.		1·0	Ref.		1·0	Ref.		1·0	Ref.	
Age (years)																									
40–49	686	1·0	Ref.		1·0	Ref.		1·0	Ref.		1·0	Ref.		3·4	1·7, 7·2	<0·001***	1·2	0·5, 2·8	0·719	1·6	0·5, 5·0	0·565	1·7	0·4, 6·3	0·448
50–59	486	2·0	1·2, 3·1	0·005**	1·5	0·9, 2·5	0·102	1·5	1·1, 1·9	0·003**	1·2	0·9, 1·6	0·154	2·3	1·1, 5·0	0·038*	1·6	0·7, 3·6	0·293	0·8	0·2, 3·3	>0·999	0·6	0·2, 2·4	0·476
60–69	541	4·4	2·9, 6·6	<0·001***	2·9	1·8, 4·5	<0·001***	2·5	2·0, 3·2	<0·001***	1·8	1·4, 2·4	<0·001***	1·4	0·6, 3·0	0·550	1·7	0·8, 4·0	0·185	1·0			1·0		
≥70	290	5·0	3·2, 7·9	<0·001***	3·1	1·9, 5·1	<0·001***	3·4	2·6, 4·6	<0·001***	2·3	1·7, 3·2	<0·001***	1·0	Ref.		1·0	Ref.		–			–		
Literacy																									
Literate	676	1·0	Ref.		1·0	Ref.		1·0	Ref.		1·0	Ref.		2·8	1·9, 4·1	<0·001***	2·3	1·4, 3·7	0·001**	8·0	2·4, 26·4	<0·001***	7·0	1·7, 29·3	0·008**
Illiterate	1327	4·7	3·1, 7·1	<0·001***	2·7	1·7, 4·5	<0·001***	2·7	2·2, 3·3	<0·001***	1·7	1·4, 2·2	<0·001***	1·0	Ref.		1·0	Ref.		1·0	Ref.		1·0	Ref.	
Household income‡																									
Unemployed	897	3·6	1·9, 6·9	<0·001***	1·2	0·6, 2·5	0·663	3·4	2·4, 4·8	<0·001***	2·1	1·4, 3·1	<0·001***	2·6	1·6, 4·3	<0·001***	3·4	1·8, 6·3	<0·001***	8·5	1·4, 52·2	0·022*	4·8	0·5, 47·1	0·174
Farming	843	2·9	1·5, 5·6	0·001**	1·0	0·5, 2·0	0·902	3·8	2·6, 5·5	<0·001***	2·2	1·5, 3·3	<0·001***	1·0	Ref.		1·0	Ref.		1·0	Ref.		1·0	Ref.	
Paid	242	1·0	Ref.		1·0	Ref.		1·0	Ref.		1·0	Ref.		5·6	3·2, 9·8	<0·001***	1·5	0·9, 2·5	0·155	17·8	2·7, 115·1	0·003**	3·4	0·4, 31·1	0·273

Ref., referent category.
*$P < 0·05$, **$P < 0·01$, ***$P < 0·001$.
†Adjusted for all participant characteristics listed in the table.
‡21 unknowns.

0·4 % had BMI ≥ 30·0 kg/m². For females, these figures were 37·4 %, 13·0 %, 9·5 % and 1·2 %, respectively (Table 1).

On multivariate analysis, adjusting for gender, age, domicile, literacy and main source of household income, having BMI < 18·5 kg/m² was independently and significantly associated with male gender, rural domicile, being aged 60–69 years and ≥70 years compared with 40–49 years, illiteracy and the main source of household income (Table 2). Rural domicile, being aged 60–69 years and ≥70 years compared with 40–49 years and illiteracy were predictive of having BMI < 16·0 kg/m², but gender and primary source of household income were not.

No males or females had a BMI ≥ 40·0 kg/m². Female gender, urban domicile and literacy were significantly associated with having BMI ≥25·0 and ≥30·0 kg/m² on multivariate analysis (Table 2). In addition, the main source of household income being unemployment compared with subsistence farming/fishing was predictive of BMI ≥ 25·0 kg/m².

Adjusting for gender, age and domicile, and extrapolating to those aged ≥40 years across Timor-Leste, 36·0 (SD 2·1) % had BMI < 18·5 kg/m² and 9·9 (SD 1·3) % had BMI < 16·0 kg/m², being approximately 66 500 and 18 000 people, respectively. Meanwhile 6·6 (SD 1·1) % had BMI ≥ 25·0 kg/m² and 0·8 (SD 0·4) % had BMI ≥ 30·0 kg/m², being approximately 10 000 and 1500 people, respectively.

Discussion

The determinants of BMI were unlikely to be associated with survey non-participation, nor with the sporadic omission of height and weight measurements that occurred for some participants. Therefore, the results in the present study are likely representative of the Timorese population aged ≥40 years.

Compared with other Malay populations, a higher proportion of Timorese are underweight[6] and a lower proportion are overweight[11]. The people of Timor-Leste are currently among the most underweight, least overweight populations in the world[12]. The WHO states that a prevalence of 20 % or more of the adult population with a BMI < 18·5 kg/m² indicates a serious public health problem[9]. The results of the current and previous surveys[4,7] suggest that the Timorese population remains in this category, and is close to the 'critical'[9] situation of having ≥40 % of the population with a BMI < 18·5 kg/m².

The Timor-Leste Demographic and Health Surveys in 2003[7] and 2010[4] show that the proportion of women aged 15–49 years being underweight decreased from 37·7 % to 27·2 % and the proportion of women overweight rose from 3·1 % to 5·1 %. While the increase in overweight women needs monitoring given the dangers of obesity, the decrease in underweight women is encouraging if it reflects improvement in nutrition and food security. The association of rural domicile and older age

with undernutrition indicates these groups are most in need of attention by nutrition and food security programmes.

The current study found urban domicile was a predictor of being overweight and obese. Increasing urbanization, with its associated changes in activity and nutrition, is generally regarded as contributing to the rise of obesity in developing countries[1,13]. The Timorese population is likely to be at particular risk: rapid urbanization is predicted for Timor-Leste in the coming years, with an even rural–urban population distribution by 2040[14]. Also, the country has already improved its Human Development Index ranking, having moved up forty-two places to achieve a 'medium' rating in 2010[15]. Much of this was due to increased government spending from petroleum revenue, both of which are expected to continue[16].

In most parts of the world the prevalence of overweight and obesity tends to be higher for females than for males[17]. Also, it has been found in all but the least developed countries that the proportion of the adult female population overweight now exceeds that which is underweight in both urban and rural areas[18]. The findings of the current study are consistent with both these observations.

Literacy (as a proxy for educational attainment and the likelihood of a more sedentary lifestyle) was found to be a predictor of being overweight and obese. Conversely, illiteracy was a predictor of being underweight and severely thin. Having no household member in paid employment was also predictive of being underweight, but not of severe thinness.

On multivariate analysis, paid employment (as a proxy for likely increased food choices) was not predictive of being overweight or obese. This may be because the economy in Timor-Leste is still very young and the nutrition transition is in its early stages.

BMI was chosen as the anthropometric measure in the present study due to its widespread use in surveillance internationally[19,20]. While the skill required for accurate determination of waist-to-hip ratio and waist circumference[21] was considered prohibitive in the present survey, the inclusion of this measure in future would provide a more comprehensive picture of the body fat distribution in the Timorese population.

At this time, the issue of undernourishment is more prevalent in the Timorese adult population than being overweight or obese. Continued monitoring of population BMI statistics may be prudent. This would assist assessment of the effectiveness of nutrition and food security programmes currently being implemented and the planning of cost-effective preventive and early interventions for the anticipated obesity and associated diseases as urbanization and socio-economic development increase. Given that diabetes occurs at lower BMI in many Asian populations compared with elsewhere in the world[22], the inclusion of diabetes measurement in future surveys would permit the exploration of whether the same trend exists in the Timorese population.

Acknowledgements

This work was supported by The Fred Hollows Foundation New Zealand. The authors have identified no conflicts of interest. J.R. led the research project and participated in all phases of this study, including conceptualization of the study, design and analysis, and manuscript preparation. G.B. participated in conceptualization of the study design, and collaborated on the manuscript preparation. The authors acknowledge the work of the TLNEHS2010 survey team.

References

1. World Health Organization (2003) *Diet, Nutrition and the Prevention of Chronic Diseases. Joint WHO/FAO Expert Consultation. WHO Technical Report Series* no. 916. Geneva: WHO.
2. World Health Organization (2005) *Preventing Chronic Disease: A Vital Investment. WHO Global Report.* Geneva: WHO.
3. National Statistics Directorate, Ministry of Planning and Finance (2007) *Timor-Leste Survey of Living Standards 2007.* Dili: Government of the Democratic Republic of Timor-Leste.
4. National Statistics Directorate, Ministry of Planning and Finance (2010) *Timor-Leste Demographic and Health Survey 2009–10 Preliminary Report.* Dili: Government of the Democratic Republic of Timor-Leste.
5. Ministry of Agriculture and Fisheries (2009) *Seeds of Life Annual Research Report 2009.* Dili: Government of the Democratic Republic of Timor-Leste.
6. International Food Policy Research Institute, Concern Worldwide & Deutsche Welthungerhilfe (2010) *2010 Global Hunger Index. The Challenge of Hunger: Focus on the Crisis of Child Undernutrition.* Bonn, Washington, DC and Dublin: IFPRI, Concern Worldwide and Deutsche Welthungerhilfe; available at http://www.ifpri.org/sites/default/files/publications/ghi10.pdf
7. National Statistics Directorate, Ministry of Planning and Finance (2003) *Timor-Leste 2003 Demographic and Health Survey.* Dili: Government of the Democratic Republic of Timor-Leste.
8. World Health Organization Expert Consultation (2004) Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* **363**, 157–163.
9. World Health Organization (1995) *Physical Status: The Use and Interpretation of Anthropometry. Report of a WHO Expert Committee. WHO Technical Report Series* no. 854. Geneva: WHO.
10. Pan WH & Yeh WT (2008) How to define obesity? Evidence-based multiple action points for public awareness, screening, and treatment: an extension of Asian-Pacific recommendations. *Asia Pac J Clin Nutr* **17**, 370–374.
11. Gill T (2006) Epidemiology and health impact of obesity: an Asia Pacific perspective. *Asia Pac J Clin Nutr* **15**, Suppl., 3–14.
12. World Health Organization (2011) *Global Database on Body Mass Index.* Geneva: WHO; available at http://www.who.int/bmi/index.jsp
13. Popkin BM (2003) Dynamics of the nutrition transition and its implications for the developing world. *Forum Nutr* **56**, 262–264.
14. The World Bank (2008) *Policy Note on Population Growth and its Implications in Timor-Leste.* Washington, DC: The World Bank; available at http://go.worldbank.org/M9DINVAJ90

15. United Nations Development Programme (2010) *Human Development Report 2010. The Real Wealth of Nations: Pathways to Human Development*. New York: UNDP.
16. The World Bank (2007) *Economic and Social Development Brief*. Dili: The World Bank; available at http://www.adb.org/Documents/Books/ESDB-Timor-Leste/ESDB-Timor-Leste.pdf
17. Kelly T, Yang W, Chen CS *et al*. (2008) Global burden of obesity in 2005 and projections to 2030. *Int J Obes (Lond)* **32**, 1431–1437.
18. Mendez MA, Monteiro CA & Popkin BM (2005) Overweight exceeds underweight among women in most developing countries. *Am J Clin Nutr* **81**, 714–721.
19. World Health Organization (2008) *WHO Global Strategy on Diet, Physical Activity and Health: A Framework to Monitor and Evaluate Implementation*. Geneva: WHO.
20. World Health Organization (2011) *The WHO STEPwise Approach to Chronic Disease Risk Factor Surveillance (STEPS)*. Geneva: WHO; available at http://www.who.int/chp/steps
21. World Health Organization (2011) *Waist Circumference and Waist–Hip Ratio: Report of a WHO Expert Consultation, Geneva, 8–11 December 2008*. Geneva: WHO.
22. Yoon KH, Lee JH, Kim JW *et al*. (2006) Epidemic obesity and type 2 diabetes in Asia. *Lancet* **368**, 1681–1688.