Institution: University of Warwick

Unit of Assessment: A1 – Clinical Medicine

Title of case study: Prevention of Cardiovascular Disease by Dietary Salt Reduction

1. Summary of the impact

Many research groups around the world have produced evidence that cardiovascular disease (CVD) can be prevented by dietary salt reduction. The specific contribution of the University of Warwick consists of primary research carried out between 2005 and 2013 by Professor Francesco Cappuccio, who has demonstrated that lower salt intake can lead to a reduction in strokes and total cardiovascular events. These results have informed public health awareness and policy-making both nationally and globally. The research contributed directly to the development of a national policy for salt reduction by the UK National Institute for Health and Care Excellence (NICE) in 2010 by indicating the likely health gains of a population strategy. The research also influenced global policies set out by the World Health Organization (WHO) in 2007, 2010 and 2012. Population-wide reductions in dietary salt are now the second priority after tobacco control set by the United Nations in 2011 for the prevention of non-communicable disease worldwide.

2. Underpinning research

Cardiovascular disease (CVD) is the most common cause of death and disability in the world — responsible for over 10M deaths and at least as many disabilities globally every year (Global Burden of Disease). According to the WHO, high blood pressure (BP) is the first attributable cause of CVD. Effective drug therapy is now available to lower BP in people with hypertension. However, pharmacological interventions, although cost-effective in comparison with available treatments for other conditions, are still expensive and not always accessible in low and middle-income countries. Importantly, BP lowering treatments are directed exclusively towards people with a very high risk of hypertension, whereas the majority of CVD occurs in people with BP in a lower range where drug therapy is not recommended. Thus, a non-pharmacological approach to lower BP in the general population would yield the maximum benefit in terms of reduced risk of CVD. A reduction in dietary salt intake lowers BP and reduces CV events, such as strokes and heart attacks. Although the effects of reduced salt intake on BP have been known for decades, the development and implementation of public health policies gained momentum after the publication of new WHO recommendations in 2007, which were supported substantially by new data from Warwick Medical School (WMS).

The research underpinning the development and implementation of dietary salt reduction policies nationally and globally was carried out by Professor Francesco Cappuccio (Cephalon Chair of Cardiovascular Medicine & Epidemiology, 2005–present) and his research group (Dr Michelle Miller, Reader in Biochemical Medicine 2006-present and Dr Chen Ji, Research Fellow 2006-present). Since joining Warwick in 2005, Cappuccio has focused on extending his early research that consisted of small randomised control trials (RCTs) into a systematic review and meta-analysis of prospective population studies on the effects of high salt intake on BP (1). His work has produced evidence that salt intake is associated with increased risk of CVD, in particular stroke (2). A systematic review and meta-analysis of all published prospective population data in >177,000 participants followed for 3.5 to 19 years found a 23% increase in stroke incidence and a 17% increase in total cardiovascular events amongst people with high salt intake (2). This evidence has been highly cited and has influenced subsequent national and international policy making (see sections 4–5). Cappuccio also carried out the first community-based RCT of salt restriction in sub-Saharan Africa. All fieldwork for this study was completed under his supervision at St George's, University of London, but analyses leading to significant contributions to policy were conducted after Cappuccio moved to Warwick in 2005 (3). Cappuccio studied over 1,000 men and women living in semi-urban and rural Ashanti, Ghana, assessing them at baseline and after 6 months of a health promotion intervention that aimed to increase awareness of the need to limit salt consumption. The intervention was carried out by trained community health workers and administered to all villagers. One-hour meetings were held daily in the first week and weekly thereafter in communal areas. Flip charts were used with visual images on one side (shown to participants) and written text on the other (to prompt health workers). Reduction in salt intake

averaged ~0.6g per day with a reduction of average systolic BP of ~0.4mmHg at 3 months and ~0.3mmHg at 6 months. The study proved the feasibility of dietary salt reduction at the population level in low-income countries and its efficacy in reducing blood pressure (3). As a result of this influential work WMS was designated as a WHO Collaboration Centre for Nutrition in 2008. As such, we were responsible for supporting governments in setting up systems to monitor salt intake. These efforts have been successful in Slovenia (4), where ~1g reduction in population salt intake was achieved in 5 years (2007-2012). Our work contributed to the development of policy options that were underpinned by research carried out at WMS. We applied principles of monitoring and surveillance to dietary salt intake in Slovenia (4), described for the first time inequalities in dietary salt intake related to socioeconomic status in Great Britain (5), and suggested various policy options (6) which have been adopted by the WHO.

3. References to the research

1. Aburto NJ *et al*. Effect of lower sodium intake on health outcomes: systematic review and meta-analysis. *BMJ* 2013; 346: f1326. doi: 10.1136/bmj.f1326**. [REF2 UoA1 submission]**
2. Strazzullo P *et al*. Salt intake, stroke and cardiovascular disease: meta-analysis of prospective studies. *BMJ* 2009; 339:b4567. doi: 10.1136/bmj.b4567**.** Cited in NICE PHG 25, 2010; Ministry of Health Canada 2010]. **[REF2 UoA1 submission].**
3. Cappuccio FP *et al*. A community programme to reduce salt intake and blood pressure in Ghana (IRSCTN 88789643). *BMC Public Health* 2006; 6: 13. doi: 10.1186/1471-2458-6- 13. [Cited in WHO 2007a]
4. Ribič CH *et al*. Salt intake of the Slovene population assessed by 24-hour urinary sodium excretion. *Public Health Nutrition* 2010; 13(11): 1803-9. doi: 10.1017/S136898001000025X.
5. Ji C *et al*. Spatial variation of salt intake in Britain and association with socio-economic status. *BMJ Open* 2013; 3:e002246. doi:10.1136/bmjopen-2012-002246
6. Cappuccio FP *et al*. Policy options to reduce population salt intake. *BMJ* 2011;343:402-5. doi: 10.1136/bmj.d4995

Related peer-reviewed funding

- European Commission — Seventh Framework Programme (Hypergenes - EC 201550): €11.0M (£10.0M). Awarded to FP Cappuccio and other 18 European partners (Warwick £393,172) (2008–2011).
- The Bupa Foundation (MR-12-002). Spatial variation in salt intake in Britain and effect of socio-economic status: £56,215. Awarded to FP Cappuccio (2012–2013).

Awards

- World Health Organization Collaborating Centre for Nutrition (Centre Ref. No.: UNK-219) - Head: FP Cappuccio (2008–present).

4. Details of the impact

The demonstration by Warwick researchers that reduced dietary salt intake lowers BP in a dose–dependent manner (1) and in different geographic settings (3-4) across individuals with various baseline levels of BP (1) gave impetus to national and global health policy developments. Crucially, the prospective association of reduced salt intake with a lower risk of fatal and non-fatal CVD events underpinned the development of national salt reduction programmes in the UK (2008 – 2012) (a) and internationally (2010–2013) (b–e).

National and international recommendations on dietary salt intake. Dietary salt intake is high in almost all populations, and its reduction would lead to a reduction in strokes and heart attacks (2). Through the WHO Collaborating Centre at Warwick and Cappuccio's participation in various committees (Population Reduction in Salt Intake, WHO, Geneva [2006]; European Salt Initiative, WHO, Copenhagen [2006]; European Salt Action Network [2007; founding member and lead of a subgroup], Public Health Program Development Group for NICE Guidance on Prevention of Cardiovascular Disease [2008–2010] and Expert Testimony; Cardiovascular Disease Prevention through Dietary Salt Reduction, PAHO/WHO, Washington DC [2009–2012; subgroup lead]; and Advisory Group on Nutrition, WHO Geneva [2012–2016]), we have influenced the adoption of

policies leading to reduced salt intake and have written protocols, guidelines and recommendations on how to encourage lower salt intakes (a; b; d; g; j-l).

Policies to control salt intake are now recommended by the WHO and most governments, and have been endorsed at the United Nations High Level Meeting on the Prevention of Non-Communicable Disease (2011). In 2007, WHO re-stated recommendations of salt targets of 5g per day. Since then, it has developed policies in every continent for the implementation of population salt reduction programmes under the WHO Action Plan on Obesity, Diet and Physical Activity[b]. The WHO 65th World Health Assembly (2012) decided that population dietary salt should be reduced and should be a priority alongside tobacco control for the reduction of non-communicable disease worldwide. Examples of early adopters of these policies are Slovenia (monitoring and surveillance 2008-13), Argentina, Costa Rica and Chile (monitoring tools 2010-13) and South Africa (regulation 2012) (b; d; e).

Increased public awareness. In addition to scientific dissemination through publications, reviews, editorials and international meeting presentations on the findings of underpinning research, Warwick researchers have contributed to the three-pronged approach of salt reduction programmes: consumer awareness, food reformulation, monitoring and surveillance (Sutherland J *et al.* Br J Nutr 2013;110:552-8 - Brinsden HC *et al.* BMJ Open 2013;3:e002936). Since 2008, the WHO Collaborating Centre at Warwick has held the mandate to work within a global platform to increase research output and operational support to WHO offices (Geneva [Global], Copenhagen [Europe], Washington [PanAmerican], and Cairo [Eastern Mediterranean), and to lead and support monitoring and surveillance in individual countries. We have participated and contributed directly through the WHO Global Platform to all aspects of the three-pronged approach (b; d; e). We have engaged in additional dissemination activities through our website (www2.warwick.ac.uk/go/cappuccio/research_impact) and partnership with non-governmental organizations, such as Consensus Action on Salt and Health (CASH) (h) and the UK Health Forum (i).

Impact on public health and economy. Public health benefits have been achieved through an increased public awareness about the importance of lowering individual salt intake; through industry engagement for the re-formulation of food with lowered salt content; and in the monitoring of salt intake nationally through repeated surveys (Millett C *et al.* PLoS ONE 2012; 7(1): e29836 - Shankar B *et al.* Health Econ 2013; 22:243-50). Crucially, in England and Wales the salt reduction programme has led to reduced salt intake from 9.5g per day in 2001 to 8.1g per day in 2010, a reduction of 1.4 g per day (or 15%). This reduction is estimated to have averted 20,000 CVD events in the UK, of which 8,500 would have been fatal (f) with ~131,000 Quality-Adjusted Life Years (QALY) gained. A gain in QALY indicates an extension of life free from illness. Our contribution is clearly listed in a salt reduction timeline published by CASH (h).

In addition to substantial health gains for the population, reduction of daily salt intake by 3g per day would lead to economic gains, an annual equivalent savings of at least £40M a year in the UK[f]. Globally, a 15% reduction of salt intake over 10 years could avert 6.5M deaths from CVD at a cost ranging between $0.04 and $0.32 per person (g).

5. Sources to corroborate the impact

a. NHS National Institute for Health and Clinical Excellence. *Prevention of cardiovascular disease at population level*. NICE Public Health Guidance 25, June 2010 (Cappuccio FP. Expert testimony on salt and cardiovascular disease, February 2009, cited in Annex Report 3) – UK public health recommendations to prevent cardiovascular disease through population salt reduction programmes and target settings for dietary salt.
b. WHO. Reducing salt intake in populations: report of a WHO forum and technical meeting. WHO Geneva 2007; pp.1-60 (ISBN 978-92-4-159537-7) – global recommendations to reduce population dietary salt intake to prevent cardiovascular disease.
c. Ministry of Health of Canada. Sodium reduction strategy for Canada. July 2010 (ISBN: 978-1-100-16232-4) – Canadian recommendations to prevent cardiovascular disease through population salt reduction programmes and target settings for dietary salt.
d. WHO. Strategies to monitor and evaluate population sodium consumption and sources of

sodium in the diet. WHO Geneva 2011 (ISBN 978-92-4-150169-9) – global recommendations for the monitoring and evaluation of population salt intake.

e. World Health Organization. Guideline: Sodium intake for adults and children. Geneva, World Health Organization (WHO), 2012, pp.1-56 [ISBN 978 92 4 150483 6] - global recommendations to reduce population dietary salt intake to prevent cardiovascular disease.
f. Barton P *et al*. Effectiveness and cost effectiveness of cardiovascular disease prevention in whole populations: modelling study. BMJ 2011; 343:d4044 – a health economic evaluation of population salt reduction based on NICE Public Health Guidance 25
g. Asaria P et al. Chronic disease prevention: health effects and financial costs of strategies to reduce salt intake and control tobacco use. Lancet 2007; 370:2044-53 - a health economic evaluation of population salt reduction based on WHO data
h. Consensus Action on Salt and Health (www.actiononsalt.org.uk/salthealth/Recommendations%20on%20salt/index.html)
i. UK Health Forum (www.ukhealthforum.org.uk/who-we-are/our-members/individual-and-associate-members/)
j. WHO. Creating an enabling environment for population-based salt reduction strategies. WHO Geneva 2010; pp. 1-42 (ISBN: 978-92-4-150077-7)(citing 2,ii) - global recommendations for the methods to implement a salt reduction programme
k. PAHO/WHO. Salt Smart Americas. A guide for Country-Level Action. Washington (DC), USA, 2013; pp. 1-174 www.paho.org/hq/index.php?option=com_content&view=article&id=8677%3Atechnical-document-salt-smart-americas&catid=5387%3Ahsd02k-salt-reduction-media-center&Itemid=39984&lang=en - summary of recommendations for the implementation of the three-pillar approach including a section on Monitoring and Surveillance
l. **Supporting Statement**: Regional Advisor and Unit Chief, Non-communicable Diseases and Disabilities, Pan American Health Organization, World Health Organization (WHO) (Identifier 1).