The China Seven Cities Study (CSCS) consortium: adapting evidence-based prevention science from west to east

Paula H Palmer, PhD,¹ Bin Xie, PhD,¹ Liming Lee, MD, PhD,² Chih-Ping Chou, PhD,³ Ping Sun,³ Bree Hemingway, BA,¹ C. Anderson Johnson, PhD¹

¹School of Community & Global Health, Claremont Graduate University, 180 East Via Verde, Suite 100, San Dimas, CA 91773, USA

²Chinese Academy of Medical Sciences & Peking Union Medical College, DongDan SanTiao 9, DongCheng District, Beijing 100730, China

³Institute for Health Promotion and Disease Prevention Research, University of Southern California, 1000 S. Fremont Ave, Alhambra, CA 91803, USA

Correspondence to: P H Palmer
paula.palmer@cgu.edu

Cite this as: *TBM* 2011;1:283–288
doi: 10.1007/s13142-011-0036-0

Abstract

Chronic, noncommunicable diseases (NCDs) have surpassed infectious diseases as the primary cause of death and disability in most developing nations. Nowhere is this more evident than in China where NCDs account for 80% of all deaths and skyrocketing medical costs. Driving the escalation of NCDs are high rates of tobacco use, longer life spans, and changes in the traditional Chinese diet and lifestyle bolstered by unprecedented economic growth and the new global culture. Despite the epidemic of NCDs, few evidence-based interventions either to prevent or retard their progression exist in China. We present a case for the development and adoption of such strategies as effective tools to combat China's greatest health threat. Finally, we offer an example of a collaborative network linking Chinese public health and academic institutions with US researchers to promote the translation of western evidence-based interventions that fully incorporate local knowledge, culture, and capacity.

Keywords

Noncommunicable disease, Tobacco control, China, Evidence-based

As low- and middle-income countries industrialize, urbanize, and integrate features of western culture with their traditional lifestyle, rates of noncommunicable diseases (NCDs) rise and portend alarming trends for the future. Globally, 35 million deaths annually are attributable to cardiovascular diseases (CVDs), chronic respiratory diseases, diabetes, and cancer with 80% of these occurring in developing nations [1]. In resource-poor developing nations where health-care systems are often woefully underfunded, understaffed, and in flux, population-based approaches to combating NCDs may produce the greatest and most cost-effective results. The value of incorporating evidence-based, prevention-focused strategies that can be rolled out into communities has been demonstrated in developed nations [2]. To date, however, very few evidence-based approaches for health risk behavior modification have been utilized in economically developing nations [3].

Implications

Practice: When adapted to local culture and circumstances, evidence-based, prevention-focused strategies derived from western models can be effective in the reduction of noncommunicable diseases in developing nations, such as China.

Policy: Given China's size, population, and healthcare system in transition, the utilization of population-based interventions can provide a cost-effective means of improving health outcomes.

Research: Research in developing nations should fully involve local collaborators, build capacity, and be drawn upon applicable western models and theories.

THE NCD EPIDEMIC IN CHINA

Like other developing nations, China struggles with an epidemic of NCDs, which now account for 80% of deaths and 70% of disability-adjusted life years [4, 5]. China's status as the most populous nation with 20% of the world's population magnifies the urgency for effective strategies to reduce its NCD burden. Besides human suffering, loss to the Chinese economy from the consequences of diabetes, heart disease, and stroke between 2005 and 2015 will amount to \$550 billion [6]. Thirty percent of Chinese adults are either overweight or obese [7], and estimates are that 92.4 million Chinese, nearly 10% of the adult population, suffer from type 2 diabetes, more than any other nation with future sharp increases expected [8–11].

As the world's largest producer and consumer of tobacco, China has 320 million smokers, one third of the world's total, and one million tobacco-related deaths annually from cancer, CVD, and respiratory diseases [12]. Chinese males have among the highest rates of cigarette smoking globally at over 60% and while female rates have been historically low, this is changing as traditional norms that discourage tobacco use are eroding to western media influences and aggressive

tobacco marketing campaigns [13–15]. Especially troubling is the increase in youth smoking and initiation taking place earlier in life [13, 16]. Clearly, Chinese public health leaders have an NCD crisis in the works.

CHINA SEVEN CITIES STUDY: A MODEL OF EAST-WEST COLLABORATION

It was out of deep concern over escalating rates of adolescent tobacco use and absence of tobacco control programs that in 1998, the public health leadership in the central Chinese city of Wuhan sought assistance from US health behavior researchers. With initial generous in-kind support from the Wuhan municipal government and subsequent 10-year continuous funding from the US National Cancer Institute for the Pacific Rim Transdisciplinary Tobacco and Alcohol Use Research Center (PR-TTAURC) [17, 18], a unique transnational collaboration of research, training, and capacity building developed and continues to this day.

In 2002, with the support of the leadership of China’s new national Center for Disease Control and Prevention, five additional municipal Centers for Disease Control (CDC) and a municipal health education institute joined the Wuhan CDC and the US research team to form the China Seven Cities Study (CSCS) consortium, a companion research group of the PR-TTAURC [13]. The participating seven cities, which span much of the geographic, economic, and cultural diversity of China, are Harbin and Shenyang in the northeast, Wuhan in the center, Chengdu and Kunming in the west-southwest, and Hangzhou and Qingdao in the economically developed coastal regions. Collaborating with the US university research team and the municipal CDCs are the local health bureaus and education committees, and universities in each of the seven participating cities, in addition to the China National CDC, Peking University School of Public Health, and Peking Union Medical University. The CSCS consortium membership is presented in Fig. 1.

The primary objective of the CSCS is to reduce the burden of NCDs by assessing trends and influences on tobacco and alcohol use, rising rates of obesity and sedentary lifestyle, mental health, and HIV to inform the development of evidence-based interventions for schools and communities suited to Chinese culture and conditions. The CSCS serves as the umbrella for a series of research studies wholly carried out in China, some of which support ongoing PR-TTAURC research projects and others that either stand alone or provide pilot data to inform future research projects and grant applications. Figure 2 provides a timeline, description of CSCS research activity, and its relationship to the PR-TTAURC.

While the CSCS began with a focus on tobacco control, our Chinese colleagues requested that we also include other areas of health promotion research relevant to their particular city. The CSCS research agenda is developed collaboratively during annual CSCS Planning Meetings, which rotate between each of the seven cities and bring together the US and Chinese teams for discussion, training, and establishing the year’s activities. For example, at the 2002 planning meeting, concern over the lack of local health behavior risk data led to a series of longitudinal and cross-sectional risk assessments (2002–2005) with 59,000 middle and high school youth and their parents, college students, and adult workers across all seven cities [13]. These data on sociocultural environmental factors, tobacco use, environmental tobacco exposure, alcohol use, dietary intake, physical activity, psychosocial stressors, and general health measures as well as blood sample collections for biomarkers assessments of glucose, insulin, and lipid profile have proven valuable for public health departments in each city for program planning, publications, and dissemination to citizens. Moreover, the data have served to seed joint grant proposals between the Chinese and US collaborators to fund local research capacity infrastructure, health promotion intervention development, as well as short- and long-term training for Chinese public health personnel in the USA.

Fig 1 | PR-TTAURC: members of the CSCS consortium

Fig 2 | PR-TTAURC: Research timeline and relationship between past, present, and future studies in China

In terms of the CSCS organization and management structure, each participating city's CDC or Health Education Institute Director and US principal and co-principal investigators form the CSCS Steering Committee. This committee makes decisions on where (e.g., schools, clinics, etc.) to carry out agreed upon research activities, personnel assignments, and types of training that may be needed and also deals with any logistical challenges that may occur. While the cities provide some in-kind support, funding also comes from US grant sources, and financial arrangements vary from city to city depending upon the project. The US team provides training on a range of topics, including project management, data management, research methodology, statistical analysis, paper writing, measure development and validation, intervention development, and protection of human subjects. At the beginning of the CSCS, only the Wuhan CDC had an IRB in place. However, each city has since worked to establish a local IRB for review of research protocols and informed consent documents. It should be noted that all CSCS datasets are shared by the Chinese and US teams.

ADAPTING WESTERN THEORIES TO CHINESE CONDITIONS: THE CASE OF SMOKING PREVENTION

To date, PR-TTAURC and CSCS researchers have developed and implemented two school-based tobacco prevention trials for adolescents, the first in Wuhan [19] and second in Chengdu [20, 21]. The

municipal public health departments in both cities volunteered to have the programs developed and tested in their cities. The Wuhan Smoking Prevention Trial (WSPT) (1999–2004) for middle school youth, which laid the groundwork for the CSCS, was based on social normative theory with the goal of both preventing initiation among nonsmokers and progression to higher levels of tobacco use among youth already smoking. Chinese school personnel and USA-trained Chinese researchers evaluated the western materials and made changes to accommodate Chinese conditions. Pilot testing found that social influence-based interventions developed in the USA needed only slight modification to be acceptable to Chinese school settings. Besides language translation, other adjustments included adding content specific to Chinese smoking rates and antitobacco policies, replacing US tobacco ads with Chinese versions and substituting interactive peer leader-led activities for the traditional Chinese didactic teaching style. Modifications also had to be made for large Chinese classes with perhaps some loss of supervision over small group activities. On the whole, however, the Socratic-style program delivery and specific intervention activities remained similar to the US version [19].

The WSPT exposed a dispositional characteristic by program interaction wherein students experiencing high levels of depression and/or impulsivity/hostility were positively affected to a greater extent by the interventions than those scoring lower on those characteristics. That is, the experimental program was profoundly more effective in preventing transition from smoking experimentation to more regular smoking among those with higher levels of depression and

impulsivity/hostility [20]. These findings were replicated in a related co-occurring trial with a multiethnic cohort in California [21]. From a theoretical perspective, influences on smoking uptake and progression were found to be much the same in China as the USA, including perceptions of social norms, dispositional characteristics (depression and impulsivity), and causal attributions [22–25]. One difference was that parent, teacher, and other adult smoking practices played a more important role relative to peer smoking in the Chinese than in the US population [22]. Overall, the research suggests that social influence approaches when adapted to cultural differences may be efficacious in international settings.

The Chengdu Smoking Prevention Study (CSPS) (2005–2010) for high school students expanded the social influences approach to incorporate a broader view of the factors that promote tobacco use. Program development took into consideration students' cultural/environmental influences, dispositional characteristics, particularly impulsivity, hostility, depression, mindfulness (attention), and affective decision making, and how these features impact substance use uptake and progression. In addition, findings from the CSCS-Chengdu Neurocognitive Study (CNS) added important knowledge about the neurocognitive basis for rapid acceleration in smoking and drinking behavior, involving multiple neural pathways regulating affective (emotionally laden) decisions [26–28]. The CSCS Longitudinal Study dataset with health risk behavior and psychosocial information for over 14,000 Chinese adolescents also provided valuable input to program development.

The US and Chinese research teams spent considerable time conducting validation studies on western measures for Chinese students through brief surveys and debriefing sessions. Curriculum components were co-developed by Chinese graduate students, public health personnel, and the US research team. Multiple iterations were reviewed in student focus groups coconducted by US and Chinese graduate students [29]. The main trial and booster interventions were delivered by Chinese graduate students trained by the US research team. Results of the CSPS trial are currently being analyzed.

CSCS research carried out over the last decade has afforded this unique Chinese–American partnership the opportunity to investigate the impact of NCDs and consider how what we have learned in the west might benefit China. PR-TTAURC and CSCS investigators and graduate students have produced over 140 peer-reviewed publications, thus providing a wealth of information, which may contribute to future health promotion strategies. As an example, we have found that western media exposure and disposable income are associated with the adoption of certain health-risk behaviors such as smoking [30] and weight dissatisfaction among Chinese adolescents [31]. In our transnational comparisons, we have observed increasing rates of overweight/obesity among youth in more economically developed areas of China, such as the

eastern coastal region and among Chinese immigrant populations in the USA [32, 33].

Other PR-TTAURC and CSCS studies have included an investigation of substance use among adolescent twin pairs in California and Qingdao to quantify the nature of environmental influences and how they interact with familial and genetic sources of variation in smoking-related behaviors [34]; an investigation of genetic factors underlying tobacco and alcohol use progression and their prevention [35]; a family study of cardiovascular risk factors in Qingdao [36], a study of the development and validation of a Chinese version of the Food Frequency Questionnaire for youth and adolescents [37]; an assessment of cognitive and neural mechanisms underlying tobacco and alcohol abuse [25–27]; and an assessment of tobacco use among rural Chinese children and their parents [38].

WORKING CROSS CULTURALLY: LESSONS LEARNED

Working cross culturally is as delightful as it is difficult. The can-do spirit of our Chinese colleagues and their genuine collective interest in our collaborative projects have made the work particularly rewarding. Nevertheless, intervention development and implementation with over 5,000 Chinese school children have been arduous tasks due to the sheer amount of work involved and the geographical distance between China and the USA. Lessons learned from the CSCS collaboration underscore the need for in-depth consideration of differences, that is, going beyond simple translation of existing materials when attempting to adapt health promotion strategies from culture to culture. The full engagement of all research partners in the process of translating western theories, developing materials, and implementation strategies to local circumstances is vital. We have been fortunate to have USA-trained Chinese scientists on our research team to assist with this process and to insure that we are culturally appropriate, generally, in our interactions with our Chinese colleagues.

The shared program of research has progressed the science of prevention in the domains of family, societal, neurocognitive, and genetic influences and resulted in research training for over 120 Chinese public health personnel and graduate students. It is doubtful that this full array of research findings and capacity building could have been achieved in a less transdisciplinary and internationally collaborative fashion. Cultivating long-term relationships between research collaborators when working in developing nations is vital and provides each partner with the opportunity to educate the other in the local and institutional cultures. It is incumbent upon researchers from developed nations to invest heavily in the expansion of research capacity in low- and middle-income nations so that foreign partners benefit professionally and personally from projects and feel

ownership. Research data should be shared with the local partner as should authorship on peer-reviewed papers, which are highly prized in China and other developing nations. In addition, involvement with policy makers in the foreign country can yield huge benefits by way of their enthusiasm and support (financial and general) and goes a long way in sustaining programs and carrying out future collaborations. Our public health collaborators across all seven cities were exemplary in providing facilities, staffing, transportation, access to schools and clinics, and valuable insights regarding their cities and citizens. Any difficulties that arose were discussed and settled promptly and efficiently either by face-to-face discussion or telephone calls with excellent interpreters rather than by email. Not only did we work as a team, we shared meals and traveled together on short vacations. They became our colleagues and friends, and it was the development of good *guanxi* (relationships) and trust that has sustained our collaboration as much as our research programs.

Given China's size and population density, a health care system in transition, and increasing rates of potentially modifiable health risk behaviors, evidence-based interventions can provide a cost-effective means to the prevention and reduction of NCDs. The CSCS model is instructive regarding how the transfer of evidence-based science can be effectively adapted to cultures and circumstances in the developing world.

Acknowledgments: This work was supported by the Pacific Rim Transdisciplinary Tobacco and Alcohol Use Research Center (TTAURC) and funded by the National Institutes of Health (grant no. 1 P50 CA84735-01). The authors thank the China Seven Cities Study (CSCS) directors and project staff at the Center for Disease Control and Prevention in the cities of Chengdu, Hangzhou, Harbin, Qingdao, Shenyang, and Wuhan and the Institute for Health Education in Kunming, People's Republic of China for assistance with project coordination and data collection. We also thank the principals, physicians, and teachers in the participating schools for their cooperation. Finally, we express our gratitude to the national Chinese Center for Disease Control and Prevention, Peking University School of Public Health, and the municipal government, health bureau, and education committee in participating cities for their support.

1. World Health Organization (2010). 2008–2013 action plan for the global strategy for the prevention and control of noncommunicable diseases. <http://www.who.int/nmh/publications/9789241597418/en/index.html>. Accessed 20 Oct 2010.
2. Pietinen, P., Lahti-Koski, M., Vartiainen, E., & Puska, P. (2001). Nutrition and cardiovascular disease in Finland since the early 1970s: a success story. *Journal of Nutrition, Health & Aging*, 5(3), 150–154.
3. Nugent, R. (2008). Chronic diseases in developing countries: health and economic burdens. *Annals of the New York Academy of Sciences*, 1136, 70–79.
4. He, J., Gu, D., Wu, X., et al. (2005). Major causes of death among men and women in China. *The New England Journal of Medicine*, 353(11), 1124–1134.
5. Wang, L., Kong, L., Wu, F., Bai, Y., & Burton, R. (2005). Preventing chronic diseases in China. *Lancet*, 366(9499), 1821–1824.
6. World Health Organization (2005). Preventing chronic disease a vital investment. http://www.who.int/chp/chronic_disease_report/en/. Accessed 10 Oct 2010.
7. Zhao, W., Zhai, Y., Hu, J., et al. (2008). Economic burden of obesity-related chronic diseases in Mainland China. *Obesity Reviews*, 9(Suppl 1), 62–67.
8. Normile, D. (2010). A sense of crisis as China confronts ailments of affluence. *Science*, 328(5977), 422–424.

9. Haslam, D. W., & James, W. P. (2005). Obesity. *Lancet*, 366, 197–209.
10. Wild, S., Roglic, G., Green, A., Sicree, R., & King, H. (2004). Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care*, 27, 1047–1053.
11. Yang, W., Lu, J., Weng, J., et al. (2010). Prevalence of diabetes among men and women in China. *The New England Journal of Medicine*, 362(12), 1090–1101.
12. Gu, D., Kelly, T. N., Wu, X., et al. (2009). Mortality attributable to smoking in China. *The New England Journal of Medicine*, 360(2), 150–159.
13. Johnson, C. A., Palmer, P. H., Chou, C. P., et al. (2006). Tobacco use among youth and adults in Mainland China: the China Seven Cities Study. *Public Health*, 120(12), 1156–1169.
14. Gonhuan, Y. (2010). China wrestles with tobacco control. Interview by Weiyan Cui. *Bulletin of the World Health Organization*, 88(4), 251–252.
15. Ho, M. G., Ma, S., Chai, W., et al. (2010). Smoking among rural and urban young women in China. *Tobacco Control*, 19(1), 13–18.
16. Zhang, H., & Cai, B. (2003). The impact of tobacco on lung health in China. *Respirology*, 8(1), 17–21.
17. Turkan, J. S., Kaufman, N. J., & Rimer, B. K. (2000). Transdisciplinary tobacco use research centers: a model collaboration between public and private sectors. *Nicotine & Tobacco Research*, 2(1), 9–13.
18. Unger, J. B., Cruz, T., Shakib, S., et al. (2003). Exploring the cultural context of tobacco use: a transdisciplinary framework. *Nicotine & Tobacco Research*, 5(Suppl 1), S101–S117.
19. Chou, C. P., Li, Y., Unger, J. B., et al. (2006). A randomized intervention of smoking for adolescents in urban Wuhan, China. *Preventive Medicine*, 42(4), 280–285.
20. Sun, P., Unger, J. B., Guo, Q., et al. (2007). Comorbidity between depression and smoking moderates the effect of a smoking prevention program among boys in China. *Nicotine & Tobacco Research*, 9(Suppl 4), S599–S609.
21. Johnson, C. A., Cen, S., Gallaher, P., et al. (2007). Why smoking prevention programs sometimes fail. Does effectiveness depend on sociocultural context and individual characteristics? *Cancer Epidemiology, Biomarkers & Prevention*, 16(6), 1043–1049.
22. Chen, X., Stacy, A., Zheng, H., et al. (2003). Sensations from initial exposure to nicotine predicting adolescent smoking in China: a potential measure of vulnerability to nicotine. *Nicotine & Tobacco Research*, 5(4), 455–463.
23. Ritt-Olson, A., Unger, J., Valente, T., et al. (2005). Exploring peers as a mediator of the association between depression and smoking in young adolescents. *Substance Use & Misuse*, 40(1), 77–98.
24. Guo, Q., Johnson, C. A., Unger, J. B., et al. (2007). Utility of the theory of reasoned action and theory of planned behavior for predicting Chinese adolescent smoking. *Addictive Behaviors*, 32(5), 1066–1081.
25. Grenard, J. L., Guo, Q., Jasuja, G. K., et al. (2006). Influences affecting adolescent smoking behavior in China. *Nicotine & Tobacco Research*, 8(2), 245–255.
26. Xiao, L., Bechara, A., Grenard, L. J., et al. (2009). Affective decision-making predictive of Chinese adolescent drinking behaviors. *Journal of the International Neuropsychological Society*, 15(4), 547–557.
27. Johnson, C. A., Xiao, L., Palmer, P., et al. (2008). Affective decision-making deficits, linked to a dysfunctional ventromedial prefrontal cortex, revealed in 10th grade Chinese adolescent binge drinkers. *Neuropsychologia*, 46(2), 714–726.
28. Xiao, L., Bechara, A., Cen, S., et al. (2008). Affective decision-making deficits, linked to a dysfunctional ventromedial prefrontal cortex, revealed in 10th-grade Chinese adolescent smokers. *Nicotine & Tobacco Research*, 10(6), 1085–1097.
29. Okamoto, J., Sakuma, K.L., Yan, H., Peiyuan, Q., Palmer, P.H., Johnson, A. (2010). A qualitative exploration of youth in the "New" China: perspectives on tobacco use from adolescents in Southwest China. *Asia-Pacific Journal of Public Health* (in press).
30. Islam, S. M., & Johnson, C. A. (2007). Western media's influence on Egyptian adolescents' smoking behavior: the mediating role of positive beliefs about smoking. *Nicotine & Tobacco Research*, 9(1), 57–64.
31. Xie, B., Chou, C., Spruijt-Metz, D., et al. (2006). Weight perceptions and weight-related socio-cultural and behavioral factors in Chinese adolescents. *Preventive Medicine*, 42(3), 229–234.
32. Johnson, C. A., Xie, B., Liu, C., et al. (2006). Socio-demographic and cultural comparison of overweight and obesity risk and prevalence in adolescents in Southern California and Wuhan, China. *Journal of Adolescent Health*, 39(6), 925.e1–925.e8.
33. Xie, B., Chou, C. P., Spruijt-Metz, D., et al. (2007). Socio-demographic and economic correlates of overweight status in

- Chinese adolescents. *American Journal of Health Behavior*, 31 (4), 339–352.
34. Lessov-Schlaggar, C. N., Pang, Z., Swan, G. E., et al. (2006). Heritability of cigarette smoking and alcohol use in Chinese male twins: the Qingdao twin registry. *International Journal of Epidemiology*, 35(5), 1278–1285.
35. Li, D., London S.J., Liu, J., et al. (2011). Association of the Calcyon Neuron-Specific Vesicular Protein Gene (CALY) With Adolescent Smoking Initiation in China and California. *American Journal of Epidemiology*. doi:10.1093/aje/kwq471.
36. Xie, B., Palmer, P. H., Pang, Z., et al. (2010). Environmental tobacco use and indicators of metabolic syndrome in Chinese adults. *Nicotine & Tobacco Research*, 12(3), 198–206.
37. Liu, C., Xie, B., Zhou, D., et al. (2006). Development and reliability of a Chinese youth food frequency questionnaire. *Chinese Journal of Public Health*, 22(suppl), 62–64.
38. Ma, H., Unger, J. B., Chou, C. P., et al. (2008). Risk factors for adolescent smoking in urban and rural China: findings from the China seven cities study. *Addictive Behaviors*, 33(8), 1081–1085.