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Effect of Pathological Use of the Internet on Adolescent Mental Health

A Prospective Study

Lawrence T. Lam, PhD; Zi-Wen Peng, MSc

Objective: To examine the effect of pathological use of the Internet on the mental health, including anxiety and depression, of adolescents in China. It is hypothesized that pathological use of the Internet is detrimental to adolescents' mental health.

Design: A prospective study with a randomly generated cohort from the population.

Setting: High schools in Guangzhou, China.

Participants: Adolescents aged between 13 and 18 years.

Main Exposure: Pathological use of the Internet was assessed using the Pathological Use of the Internet Test.

Outcome Measures: Depression and anxiety were assessed by the Zung Depression and Anxiety Scales.

Results: After adjusting for potential confounding factors, the relative risk of depression for those who used the Internet pathologically was about 2½ times (incidence rate ratio, 2.5; 95% confidence interval, 1.3-4.3) that of those who did not exhibit the targeted pathological internet use behaviors. No significant relationship between pathological use of the Internet and anxiety at follow-up was observed.

Conclusions: Results suggested that young people who are initially free of mental health problems but use the Internet pathologically could develop depression as a consequence. These results have direct implications for the prevention of mental illness in young people, particularly in developing countries.

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Author Affiliations: School of Medicine, Sydney, and the University of Notre Dame, Fremantle, Australia (Dr Lam); and Department of Psychological Education of Elementary School and Secondary School, Ministry of Education, and the School of Public Health, SunYat-Sen University, Guangzhou, Guangdong Province, China (Mr Peng).

PATHOLOGICAL USE OF THE Internet has been suggested as a problematic behavior that exhibits similar signs and symptoms to other established addictions since the mid-1990s.¹ While studies have indicated that individuals who pathologically use the Internet are mostly young men with introverted personalities, it has also been shown that the rates of exhibiting the behaviors among girls is increasing.²⁻⁴ In recent years, with the greater availability of the Internet in most Asian countries, pathological use of the Internet has become an increasing mental health issue among adolescents. Growing prevalence in adolescence has been reported by researchers in Taiwan and China to have increased from about 6% in 2000 to about 11% in 2004.^{5,6}

Pathological use of the Internet has been suggested to be associated with interpersonal and intrapersonal relationships, other mental health problems, and physical ill health.⁷⁻¹⁰ Studies have described poten-

tial relationships between psychiatric symptoms, aggressive behaviors, depression, and pathological Internet use among adolescents.¹¹⁻¹⁴ In the prospective study by Ko et al,¹⁵ it was further reported that depression and social phobia are found to be predictive of pathological use of the Internet in a 2-year follow-up. These results suggest that depression and anxiety may be important factors in the causal pathway of the pathological use of the Internet among adolescents.

While there is a growing wealth of literature on pathological use of the Internet among adolescents, the shortcoming of most of these studies is that they are cross-sectional by nature. Owing to the fact that the strength of evidence provided by a study with cross-sectional design is insufficient to draw any causal inference, these studies can be considered exploratory for identifying potential relationships between exposure and outcome variables.⁸ Furthermore, the focus of these studies is pathological use of the Internet

as the outcome. Information on the medium to long-term mental health effect of pathological use of the Internet among adolescents is scarce. As mentioned earlier, depression and anxiety may play a role in the development of pathological use of the Internet. However, the association between pathological use of the Internet and other mental health problems may instead indicate that using the Internet pathologically has an effect on the mental health of young people. Furthermore, these 2 factors may also share a common pathway that leads to the Internet behaviors as well as mental health problems. The limited information from the literature suggests a potential pathway that starts with mental health problems and finishes at Internet behaviors. However, no studies so far have explored the alternative direction of the pathway that begins with pathological Internet use. To determine the effect of pathological use of the Internet on the mental health of adolescents, an appropriate study type would be a cohort study with a "noncase" population. In other words, to follow a cohort of young people who are free of depression and anxiety but with various levels of Internet use and to determine their mental health outcomes at the end of the follow-up period.

To bridge the knowledge gap, this prospective study aims to examine the effect of the pathological use of the Internet on adolescent mental health, including anxiety and depression, using a noncase population. It is hypothesized that pathological use of the Internet is detrimental to the mental health of adolescents such that young people who use the Internet extensively and pathologically would have an increased risk of anxiety and depression.

METHODS

SETTING AND ETHICS APPROVAL

This prospective cohort study was conducted in Guangzhou of the Guangdong Province in Southeast China in July 2008. Guangdong Province is the most populous province in China, and Guangzhou is the capital. It is the biggest and most populated city of the province, with an estimated population of nearly 10 million in 2006. Institute ethics approval for the study was granted by the Department of Psychological Education of Elementary and Secondary Schools of the Province Administration.

SAMPLING AND PROCEDURES

The methodologies of the baseline phase of the study were described previously.⁸ In brief, the sample was generated from the total student population of adolescents who attended high school within the region and were registered with the Guangzhou secondary school registry. A stratified random sampling method with stratification according to the proportion of students in metropolitan and rural areas was used for sample generation. The sample consisted of adolescents aged between 13 and 18 years.

The cohort study was conducted on campus at different schools, with baseline data collected via a health survey carried out the same week. Participants were selected randomly from the citywide student registry. Information on the study was provided to selected students and their parents via school principals and their teachers. While there was no written consent signed by parents, students younger than 16 years were

instructed to obtain verbal consent from parents before filling in the self-reported questionnaire designed specifically for the study. For students older than 16 years (age of self-consent), consent was implicated by a voluntary response to the questionnaire. The cohort was then followed up for 9 months, with the survey conducted again on main mental health outcomes at the end of follow-up. For the present study, a "noncase" cohort was generated from the larger cohort with a screening for anxiety and depression at baseline.

MEASURES

Anxiety was measured using the Zung Self-rating Anxiety Scale,¹⁶ and depression was assessed using the Zung Self-rating Depression Scale¹⁷ at baseline as well as at follow-up. The Self-rating Anxiety Scale was a fully validated instrument designed to assess anxiety disorders.¹⁸ It consists of 20 questions on affect according to clinical symptoms of anxiety. An exemplary question is, "I feel afraid for no reason at all." Respondents were asked to answer these questions on how often they experienced these signs and symptoms in the last 3 months and rated on a Likert scale with 1 indicating a little of the time to 4, most of the time. Scores from 1 to 4 were assigned to these responses, with a total raw score ranging from 20 to 80. These scores were further categorized into 4 levels of anxiety severity: normal, less than 45; mild to moderate, 45 to 59; marked to severe, 60-74; and extreme, 75 or greater, according to the recommended cutoff.¹⁶ The Self-rating Depression Scale was a validated, standardized scale for assessing depression. Participants were asked to respond to 20 questions regarding how often they experienced certain conditions or were in certain states of mind in the last 3 months at the time of the survey. For example, one question asked the respondent to rate how often "I find it easy to do the things I used to do" on a Likert scale with 4 responses including little or none of the time, some of the time, a large part of the time, and most or all of the time. Similarly to the Self-rating Anxiety Scale, scores from 1 to 4 were assigned to these responses with a total raw score ranging from 20 to 80. These scores were further categorized into 4 levels of depression severity: normal, less than 50; mild depression, 50 to 59; moderate to marked major depression, 60 to 69; and severe or extreme major depression, 70 or greater, according to the recommended cutoff.¹⁷ The outcome measure was further dichotomized into normal, less than 50, and depressed, 50 or greater, for ease of analysis. The Chinese versions of both instruments were validated in a Chinese adolescent population with good validity and reliability.¹⁹

Pathological use of the Internet was assessed by the Internet Addiction Test, also known as the Young's Internet Addiction Scale, designed by Young.²⁰ The Internet Addiction Test is a 20-item self-reported scale, and the design was based on the concepts and behaviors exhibited by pathological gamblers as definite by the *DSM-IV* diagnostic criteria. It includes questions that reflect typical behaviors of addiction. An example question is, "How often do you feel depressed, moody, or nervous when you are off-line, which goes away once you are back on-line?" Respondents were asked to indicate the propensity of their responses on a Likert scale ranging from 1, rarely, to 5, always. A study on the psychometric properties of the Internet Addiction Test suggested good reliability, with Cronbach α values ranging from .82 to .54 for various factors.²¹ Total scores were calculated, with possible scores ranging from a minimum of 20 to a maximum of 100. The severity of addiction was then classified according to the suggested cutoff scores, with 20 to 49 points as normal; 50 to 79, moderate; and 80 to 100, severe.²⁰ As there were only 10 students who scored 80 points or higher in this study; the exposure variable was dichoto-

mized into 2 categories, severe/moderate and normal, for ease of data analysis.

Other information collected in the survey included demographics, metropolitan or rural schools, location of family residence, whether the respondent was a single child, parental education levels, health condition, and behaviors including drinking, smoking, physical activity, and sleeping hours. Information on respondents' perceptions of family financial situation, parental expectations, burden of study, disruption to daily life, family satisfaction, and recent stressful life events was also collected. As mentioned, these variables were known to be associated with anxiety and depression among adolescents.

STATISTICAL ANALYSIS

Data were analyzed using the Stata V10.0 statistical software program.²² Bivariate analyses were conducted to examine unadjusted relationships between pathological use of the Internet, all variables of interest and anxiety, and depression. Because this was a prospective cohort study, the unadjusted Incidence Rate Ratios (IRR) and their corresponding 95% confidence intervals (CI) for anxiety, depression, pathological use of the Internet, and all variables of interest were estimated. For binary variables, the IRRs and their corresponding 95% CIs were calculated directly using the *cs* procedures of the program. For variables with more than 2 categories, Poisson regression with robust variance was used to calculate the IRRs according to the suggestion by Barros and Hirakata on rate calculation for binary outcomes.²³ Selection of potential confounding variables to be included in the multiple regression analyses was based on the significance level of these variables in the bivariate analyses. Variables that attained a significance level of $P < .1$ were included in further analysis for the adjusted relationship between the exposure and outcome variables. Poisson regression with robust variance was also used to calculate the adjusted IRRs of anxiety and depression with adjustment for potential confounding factors.

RESULTS

A total of 1618 students provided usable information on the baseline survey. Of these 1618 respondents, screening results at baseline indicated that 1122 were below the cutoff for both the Self-rating Anxiety Scale and Self-rating Depression Scale. Of the 1122 students, 1041 also responded to the follow-up questionnaire. This represented a follow-up rate of 92.8%. Comparisons between the respondents and nonrespondents indicated no statistically significant differences in terms of age, sex, and whether they attended city or rural schools. The characteristics and outcome measures of the respondents are summarized in **Table 1**. The sample consisted mainly of adolescents aged between 13 and 16 years ($n=881$; 84.7%) with a mean (SD) age of 15.0 (1.8) years. There was an almost even distribution between boys and girls and between urban and nonurban schools. In terms of demographics, most families resided in the city ($n=761$; 73.1%) and slightly more than a half were the only child in the family ($n=623$; 60.0%). Most of their parents attained at least a level of secondary education with about 17% of fathers and 12% of mothers receiving postsecondary education levels including university and postgraduate education.

In terms of health conditions and behaviors, only 21 students (2.0%) reported having experienced serious illness in the past. Most ($n=683$; 65.7%) had 6 to 8 hours of sleep on a normal weekday, and a quarter ($n=265$; 25.7%) were involved in regular physical activity each week. A few students reported that they had either tried or were smoking currently on the baseline survey ($n=15$; 2.1%), and 8% ($n=83$) reported that they had consumed alcohol more than twice at the time of the survey. Most of the students perceived their family financial situation as about the same as others ($n=669$; 64.4%). Slightly more than half perceived that they were heavily or very heavily burdened by their studies ($n=546$; 52.6%), and most ($n=846$; 81.5%) perceived that their parents had high and very high expectations of them. Slightly less than one-fifth of these students were satisfied with their family ($n=230$; 22.1%), and about half ($n=536$; 51.7%) perceived their body as normal, with about 20% ($n=214$) feeling overweight and about 30% ($n=286$) underweight.

In terms of the exposure, namely pathological use of the Internet, most respondents were classified as normal users ($n=944$, 93.6%), with 62 (6.2%) moderate and 2 (0.2%) severely at risk. The most common use of the Internet was for entertainment ($n=448$; 45.5%), followed by searching for information and knowledge ($n=276$; 28.1%) and communication with school mates, making friends, and avoiding boredom ($n=260$; 26.4%). There was a significant association between how the Internet was used and pathological use at baseline ($\chi^2=21.78$; $P < .001$). Young people who used the Internet pathologically were more likely to use it for entertainment and less likely to use it for information. At the 9-month follow-up, 8 students (0.2%) were classified as having significant anxiety symptoms and 87 (8.4%) scored higher than the cutoff of 50 on the depression scale.

The bivariate relationships between pathological use of the Internet, other variables of interest, depression, and anxiety were examined. The results were summarized in **Table 2**. As shown, pathological use of the Internet was significantly associated with depression, unadjusted for other potential confounding factors. Results suggested that students who used the Internet pathologically at baseline were more than 2 times as likely to experience depression at the 9-month follow up (IRR, 2.3; 95% CI, 1.2-4.1) compared with those who did not exhibit the targeted pathological behaviors. The results suggested that there was no significant effect of pathological use of the Internet on anxiety at follow-up (IRR, 2.0; 95% CI, 0.3-12.7). In this sample, study burden was the only potential confounding variable found to be significantly associated with a higher risk of anxiety and depression bivariately. Hence, it was included in further Poisson regression analyses to be adjusted for its effects on the relationships between Internet use and depression as well as anxiety. Other potential confounding variables suggested in the literature to be associated with depression and anxiety were also considered. These included age, sex, rural or urban residence, involvement in physical activity, family dissatisfaction, and study burden.

The results obtained from the multivariate Poisson regression analyses were also presented in **Table 3**. These results indicated that pathological use of the Internet was

Table 1. Frequency Distribution of Anxiety and Depression At Follow-up, and Pathological Use of the Internet Status, Demographics, Health Behaviors, and Perception of Personal Conditions of Adolescents At Baseline

Variable	Frequency, No. (%) ^a (n=1041)
Outcome	
Anxiety at follow-up	
Yes	8 (0.8)
No	1024 (99.2)
Depression at follow-up	
Yes	87 (8.4)
No	945 (91.6)
Exposure	
Pathological use of the internet ^a	
Severe	2 (0.2)
Moderate	62 (6.2)
Normal	944 (93.6)
Demographics	
Age group, y	
<13	213 (20.5)
13-14	314 (30.2)
15-16	354 (34.0)
≥17	160 (15.3)
Sex	
Male	491 (47.2)
Female	550 (52.8)
City school	
Yes	549 (52.7)
No	492 (47.3)
Family location	
Rural	134 (12.9)
Semirural	146 (14.0)
Urban	761 (73.1)
Single child	
Yes	623 (60.0)
No	415 (40.0)
Father's education level	
Less than senior high school	333 (33.1)
Senior high or technical school	501 (49.9)
University or higher	171 (17.0)
Mother's education level	
Less than senior high school	448 (43.4)
Senior high or technical school	457 (44.3)
University or higher	127 (12.3)

(continued)

Table 1. Frequency Distribution of Anxiety and Depression At Follow-up, and Pathological Use of the Internet Status, Demographics, Health Behaviors, and Perception of Personal Conditions of Adolescents At Baseline (continued)

Variable	Frequency, No. (%) ^a (n=1041)
Health Condition and Behaviors	
Serious illness	
Yes	21 (2.0)
No	1020 (98.0)
Sleep, h	
6-8	683 (65.7)
<6	804 (7.7)
>8	277 (26.6)
Smoking status	
Never	1020 (98.5)
Tried or smoker	16 (1.5)
Drinking	
1-2 Times	953 (92.0)
>2 Times	83 (8.0)
Physical activity	
Regularly each week	265 (25.7)
Once or twice per week	527 (51.1)
Not at all	240 (23.2)
Perception of Personal Conditions	
Family financial situation	
Poorer than others	100 (9.6)
Richer than others	270 (26.0)
About the same as others	669 (64.4)
Parental expectation	
Very high	242 (23.3)
High	604 (58.2)
Average	192 (18.5)
Study burden	
Very heavy	120 (11.6)
Heavy	426 (41.0)
Normal	492 (47.4)
Family satisfaction	
Very dissatisfied	174 (16.7)
Moderately dissatisfied	637 (61.2)
Satisfied	230 (22.1)
Body image	
Underweight	286 (27.6)
Overweight	214 (20.7)
Average	536 (51.7)

^aValid frequencies and percentages.

still significantly associated with depression but not anxiety. After adjusting for potential confounding factors, the relative risk for depression for those who used the Internet pathologically was 2½ times (IRR, 2.5; 95% CI, 1.3-4.3) that of the group who did not. No significant relationship between pathological use of the Internet and anxiety at follow-up was observed.

COMMENT

This study aimed to examine the effect of pathological or addictive use of the Internet on the mental health, including anxiety and depression, in a population of young people in Southeast China. The results suggested that pathological use of the Internet is detrimental to the mental health of these individuals. Particularly,

pathological use of the Internet at baseline is predictive of depression at the 9-month follow-up. After adjusting for potential confounding factors, there was an increased risk of depression for those who used the Internet pathologically by 1½ times compared with those who did not exhibit the targeted pathological behaviors. This result suggests that young people who are initially free of mental health problems but use the Internet pathologically could develop depression as a consequence. However, such a relationship was not demonstrated for anxiety. This study is unique in terms of its ability to demonstrate the mental health sequelae of pathological use of the Internet for young people who were initially healthy to begin with.

Owing to the lack of a similar study on the medium to long-term effect of pathological use of the Internet on

Table 2. Unadjusted Rate Ratios of Anxiety and Depression At Follow-up for Pathological Use of the Internet, Demographics, Health Behaviors, and Perception of Personal Conditions of Adolescents

Variables	Unadjusted IRR (95% CI)	
	Anxiety	Depression
Exposure		
Pathological use of the internet		
Severe/moderate	2.0 (0.3-12.7)	2.3 (1.2-4.1)
Average	1.0 [Reference]	1.0 [Reference]
Demographics		
Age group, y ^a		
<13	1.0 [Reference]	1.0 [Reference]
13-14	0.7 (0.1-4.8)	1.7 (0.9-3.0)
15-16	1.2 (0.2-6.5)	1.1 (0.6-2.1)
≥17	...	1.6 (1.2-2.6)
Sex ^a		
Male	...	0.7 (0.5-1.1)
Female		1.0 [Reference]
City school ^a		
Yes	1.5 (0.4-6.2)	1.0 (0.8-1.5)
No	1.0 [Reference]	1.0 [Reference]
Family location ^a		
Urban	0.5 (0.1-2.6)	1.0 (0.5-1.8)
Semirural	...	0.7 (0.3-1.6)
Rural	1.0 [Reference]	1.0 [Reference]
Single child		
Yes	0.7 (0.4-1.1)	0.8 (0.6-1.1)
No	1.0 [Reference]	1.0 [Reference]
Father's education level		
University or higher	2.0 (0.3-13.9)	0.6 (0.3-1.2)
Senior high or technical school	1.4 (0.3-7.3)	0.8 (0.5-1.2)
Less than senior high school	1.0 [Reference]	1.0 [Reference]
Mother's education level		
University or higher	...	0.8 (0.4-1.6)
Senior high or technical school	1.6 (0.4-6.8)	1.1 (0.7-1.6)
Less than senior high school	1.0 [Reference]	1.0 [Reference]

(continued)

adolescent mental health, comparison of results obtained from this study with others reported in the literature would be difficult. However, the results are consistent with those obtained in the general literature of pathological use of the Internet and psychiatric symptomatology in adolescence.^{4,11,13,24} Results of this study demonstrate not only a correlation between pathological use of the Internet and depression but also a direct effect of the pathological use of the Internet on the mental health of young people. Considering the results obtained in previous studies, particularly Ko et al,¹⁵ as well as the argument presented in the "Introduction," one can further hypothesize that the relationship between pathological Internet use and mental health may not necessarily be linear. It could be possible to apply a recursive model to understand the effect of pathological Internet use on the mental health of young people and its consequently greater involvement in pathological behaviors, triggering a vicious cycle that may spiral downward.

The results obtained from this study directly implicate the prevention of mental illness among young people, particularly in developing countries such as

Table 2. Unadjusted Rate Ratios of Anxiety and Depression At Follow-up for Pathological Use of the Internet, Demographics, Health Behaviors, and Perception of Personal Conditions of Adolescents (continued)

Variables	Unadjusted IRR (95% CI)	
	Anxiety	Depression
Health Condition and Behaviors		
Serious illness ^a		
Yes	6.9 (0.9-53.4)	1.7 (0.6-5.0)
No	1.0 [Reference]	1.0 [Reference]
Sleep per night, h		
<6	2.1 (0.2-18.8)	0.7 (0.3-1.7)
6-8	1.0 [Reference]	1.0 [Reference]
>8	1.9 (0.4-8.4)	1.0 (0.6-1.6)
Smoking status		
Tried or smoker	...	0.7 (0.1-5.0)
Never		1.0 [Reference]
Drinking		
1-2 Times
>2 Times
Involvement in physical activity ^a		
Not at all	1.1 (0.2-7.7)	0.9 (0.5-1.6)
Once or twice per week	1.0 (0.2-5.4)	1.1 (0.7-1.9)
Regularly	1.0 [Reference]	1.0 [Reference]
Perception of Personal Conditions		
Family financial situation		
Richer than others	2.5 (0.6-9.8)	1.0 (0.7-1.6)
Poorer than others	...	0.7 (0.3-1.6)
About the same as others	1.0 [Reference]	1.0 [Reference]
Parental expectation		
Very high	1.6 (0.2-17.2)	1.4 (0.7-2.8)
High	1.6 (0.2-13.5)	1.6 (0.9-3.1)
Average	1.0 [Reference]	1.0 [Reference]
Study burden ^a		
Very heavy	6.1 (1.0-36.1)	1.7 (1.0-3.1)
Heavy	1.7 (0.3-10.3)	1.2 (0.8-1.9)
Normal	1.0 [Reference]	1.0 [Reference]
Family satisfaction ^a		
Very dissatisfied	6.6 (0.8-56.2)	0.8 (0.4-1.5)
Moderately dissatisfied	0.7 (0.1-7.9)	0.7 (0.5-1.2)
Satisfied	1.0 [Reference]	1.0 [Reference]
Body image		
Underweight	0.6 (0.1-5.4)	0.7 (0.4-1.2)
Overweight	1.4 (0.3-6.3)	0.9 (0.5-1.4)
Average	1.0 [Reference]	1.0 [Reference]

Abbreviations: CI, confidence interval; ellipses, rate ratios could not be calculated; IRR, incidence rate ratio.

^aVariables with significance level $P < .1$.

Table 3. Adjusted Rate Ratios of Anxiety and Depression for Pathological Use of the Internet Among Adolescents

Exposure	Adjusted ^a IRR (95% CI)	
	Anxiety	Depression
Pathological use of the Internet		
Severe/moderate	1.0 (0.2-6.8)	2.5 (1.3-4.3)
Normal	1.0	1.0

Abbreviations: CI, confidence interval; IRR, incident rate ratio.

^aAdjusted for age, sex, urban or rural school, family location, serious illness, involvement in physical activities, family dissatisfaction, and study burden.

China. The results of the study indicated that young people who use the Internet pathologically are most at risk for mental problems and would develop depression if they continued the behavior. As we understand that mental health problems among adolescents bear a significant personal costs as well as costs to the community, early intervention and prevention that targets at-risk groups with identified risk factors is effective in reducing the burden of depression among young people.²⁵ Screening for at-risk individuals in the school setting could be considered an effective early prevention strategy according to recent meta-analysis.²⁶ Hence, a screening program for pathological use of the Internet could also be considered in all high schools to identify individuals at risk for early counseling and treatment.

As in all studies, there are strengths and weaknesses in this study. This is a population-based study that includes a random sample of students. No significant differences have been found between respondents and nonrespondents, suggesting a representative sample. The use of a standardized and validated assessment instrument for the outcome measure minimized some measurement biases. Moreover, because this is a cohort study, results provide further information on the effect of pathological use of the Internet on adolescent mental health, particularly depression, not just an association between the two. This study has demonstrated a chronological sequence between pathological use of the Internet and depression in a sample of healthy adolescents. Some potential limitations have also been identified in this study. First, information on outcome is obtained via a self-reported questionnaire. Hence, this constitutes a report bias in the outcome variable, although it would most likely be nondifferential bias. Second, information on the exposure variable is also collected via self-reporting and is also subject to recall or report bias. Third, not all potential confounding factors were measured and adjusted for in the analysis. Factors such as genetic variations and history of familial depression were not assessed in this study.

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Correspondence: Lawrence T. Lam, School of Medicine Sydney, University of Notre Dame Australia, Darlinghurst Campus, 160 Oxford St, Darlinghurst, New South Wales, Australia 2010 (llam@nd.edu.au).

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