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Examining the predictive validity of low-risk gambling limits with longitudinal data

Shawn R. Currie[1], David C. Hodgins[1], David M. Casey[1], Nady el-Guebaly[1], Garry J. Smith[2], Robert J. Williams[3], Don P. Schopflocher[2] & Robert T. Wood[3]

University of Calgary, Calgary, Canada,[1] University of Alberta, Edmonton, Canada[2] and University of Lethbridge, Lethbridge, Canada[3]

ABSTRACT

Aims To assess the impact of gambling above the low-risk gambling limits developed by Currie *et al.* (2006) on future harm. To identify demographic, behavioural, clinical and environmental factors that predict the shift from low- to high-risk gambling habits over time. **Design** Longitudinal cohort study of gambling habits in community-dwelling adults. **Setting** Alberta, Canada. **Participants** A total of 809 adult gamblers who completed the time 1 and time 2 assessments separated by a 14-month interval. **Measurements** Low-risk gambling limits were defined as gambling no more than three times per month, spending no more than CAN$1000 per year on gambling and spending less than 1% of gross income on gambling. Gambling habits, harm from gambling and gambler characteristics were assessed by the Canadian Problem Gambling Index. Ancillary measures of substance abuse, gambling environment, major depression, impulsivity and personality traits assessed the influence of other risk factors on the escalation of gambling intensity. **Findings** Gamblers classified as low risk at time 1 and shifted into high-risk gambling by time 2 were two to three times more likely to experience harm compared to gamblers who remained low risk at both assessments. Factors associated with the shift from low- to high-risk gambling behaviour from time 1 to time 2 included male gender, tobacco use, older age, having less education, having friends who gamble and playing electronic gaming machines. **Conclusions** An increase in the intensity of gambling behaviour is associated with greater likelihood of future gambling related harm in adults.

Keywords Longitudinal cohort study, low-risk gambling limits, problem gambling, risk factors.

Correspondence to: Shawn R. Currie, Mental Health Information Management, Evaluation and Research, Alberta Health Services—Calgary Zone, 10101 Southport Road SW, Calgary, AB, Canada T2W 3N2. Email: scurrie@ucalgary.ca
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INTRODUCTION

Approximately 80% of North Americans gamble [1–4], and 1–3% are pathological gamblers [5]. The notion of low-risk gambling limits, comparable to low-risk drinking limits [6], has been proposed by different research teams [7,8]. Many risk factors associated with problem gambling are fixed or difficult to change, such as demographic variables, proximity to gambling venues and personality traits [9]. In contrast, low-risk gambling limits focus on modifiable risk factors, in this case the intensity and frequency of gambling behaviour. Our group has previously derived a set of low-risk gambling limits using population gambling data collected in Canada [10]. A cut-off for each parameter was chosen to maximize the discrimination between the presence or absence of gambling-related harm, giving equal weighting to sensitivity and specificity.

Using this approach, we determined that gambling more than three times per month, spending more than CAN$1000 per year or spending more than 1% gross family income on gambling were associated with a significant increase in the risk of harm independent of other known predictors of problem gambling. These limits were validated in a subsequent study using a different data set [11] and with expert opinion [12]. Weinstock and colleagues [8] developed a similar set of moderate gambling limits for pathological gamblers (gambling once per month or less; spending no more than 2% income on gambling) that reliably differentiated problem-free and

symptomatic gambling. In related work, Stinchfield & Winters [13] proposed a cut-off for frequency of gambling (monthly or less) that discriminated recreational gamblers in the general Minnesota population from gamblers in treatment. A significant limitation of prior research is the cross-sectional nature of the data. The validity of the low-risk limits would be enhanced by demonstrating that gambling above one or more of the risk limits leads to greater consequences for the gambler in the future. The current study provides new data from the Leisure, Lifestyle and Life-cycle Project [14], a longitudinal cohort study of the gambling habits of adults and adolescents in Alberta.

Our objectives were to (i): assess the validity of the low-risk gambling limits for adults in predicting future harm; (ii) identify demographic, behavioural, clinical and environmental factors that predict the shift from low- to high-risk gambling; and (iii) assess whether change from low- to high-risk gambling is associated with playing electronic gaming machines (EGMs) and other casino games. For objective (i) we predicted that gamblers who begin to gamble above any of the low-risk gambling limits would experience more harm than gamblers who remained below all limits. We further predicted that the level of harm would increase with number of low-risk gambling limits exceeded. For objective (ii), we predicted that the shift from low- to high-risk gambling would be predicted by: male gender, younger age, family involvement in gambling, concurrent substance use and personality traits of impulsivity and excitement seeking. Based on research that has consistently shown EGMs and casino games to have a greater risk of short- and long-term consequences compared to other forms [15–17], we predicted that for objective (iii) gamblers who shift from low- to high-risk gambling would show increased involvement in these particular game types.

METHOD

Leisure, life-style and life-cycle project (LLLP)

Sampling procedure

The LLLP is a prospective 5-year panel study of five age cohorts of 1808 adolescents and adults living in rural and urban Alberta [14]. The data collected at each wave includes psychological, behavioural, medical and social variables used to examine the aetiology and natural progression of all levels of gambling. At time 1, a proportion of the assessment was conducted face-to-face and a proportion via telephone, including the gambling data. At subsequent intervals a web-based survey was employed to reduce the costs of data collection and increase retention in the longitudinal sample. Random digit dialling (RDD) recruited participants from the general population. A second wave of RDD sampling was used to recruit 'at-risk' gamblers ($n = 524$) who were above the 70th percentile in gambling expenditure or gambling frequency. The intention of this sample was to increase the yield of individuals who are likely to develop gambling problems during the longitudinal follow-up period. Sample weights were developed in consideration of: age–sex–geography variability, the number of individuals in the same age–sex grouping residing in the household and oversampling of at-risk gamblers [14]. The present study uses data from times 1 (February–October 2006) and 2 (November 2007–June 2008), with an interval of 14 months between assessments.

From the original sample, 227 adults declined to participate in the time 2 assessment. Compared to completers, adults who dropped out after the time 1 assessment were more likely to be younger ($t_{(1370)} = 5.64$, $P < 0.001$), male ($\chi^2 = 71.35$, $P < 0.0001$), report less income ($t_{(1239)} = 3.42$, $P < 0.001$) and score higher on the Problem Gambling Severity Index (PGSI) at time 1 ($t_{(1370)} = 2.66$, $P < 0.001$).

Adult completers

The present sample was restricted to adults [≥18 years; mean age = 39.9; standard deviation (SD) = 16.8] with valid data at times 1 and 2. We also excluded adults who reported no gambling at both time-periods ($n = 136$). The characteristics of the sample of 809 are depicted in Table 1.

Assessment of gambling

The Canadian Problem Gambling Index [18] collected information on participants' gambling habits including type and frequency of common gambling activities and total expenditure on gambling in the past year. Information on the gambling environment included the measurement of parental and sibling gambling and the percentage of friends who gamble. Gambling-related harms were assessed using the PGSI, a nine-item scale that assesses common consequences of gambling in the past 12 months. Although the PGSI is scored using the full Likert scale for each item (0–3 with a total score ranging from 0–27), we used the definition of harm developed in our original study on low-risk gambling limits [7]. In the original and subsequent studies [11], each PGSI item was scored dichotomously (0 = never; 1 = sometimes, most of the time or almost always), with harm defined as having a total score of two or higher. Using this scoring, the respondent needs to report at least two consequences of gambling to be considered as experiencing harm. In comparisons with other PGSI cut-offs, we found this to be the optimal definition of harm in population studies [19]. We also reasoned that

Table 1 Description of longitudinal adult sample from the leisure, life-style, life-cycle project: (n = 809).

Variable	*n*	*% (weighted)*
Age (years)		
18–20	146	25.6
23–25	182	27.1
43–45	283	32.4
63–65	198	14.9
Gender		
Male	348	49.7
Female	461	50.3
Ethnicity		
Caucasian	742	90.8
Non-Caucasian	63	9.2
Marital status		
Never married	301	49.7
Married or common-law	408	41.1
Divorced or widowed	98	9.2
Employment status		
Part or full time	587	74.1
Unemployed, retired, or homemaker	222	25.9
Annual household income		
$0–29 999	103	12.2
$30 000–49 000	119	15.5
$50 000–74 999	167	20.2
Over $75 000	381	52.1
Health		
Smokers	185	19.3
Good–excellent physical health	638	78.1
Good–excellent mental health	737	91.0

individuals endorsing gambling-related problems in two different areas could be viewed as beginning to experience problems related to their gambling.

Each participant's gambling habits at times 1 and 2 were classified as either low risk or high risk according to each of the three low-risk gambling limits (i.e. gambled above the low risk limits for frequency, total dollars spent or percentage of household income spent) as well as whether they were above one, two or three of the limits. To examine the cumulative risk associated with gambling above more than one limit, these categories were not mutually exclusive.

Assessment of other risk factors

We assessed other empirically derived risk factors for problem gambling [9], including demographics (gender, age, education), tobacco use ('smoker' versus 'non-smoker'), alcohol use (regular–occasional drinker versus non-drinker), life-time alcohol or drug dependence (coded as present or absent based on validated diagnostic modules [20]), major depression in the last 12 months (based on DSM-IV criteria) and continuous measures of impulsivity and excitement-seeking from the Revised NEO Personality Inventory [21].

Data analysis

Missing data in the LLLP study were minimal (<2%), so a mean substitution procedure was used. Statistical comparisons of proportion and calculated odds ratios (OR) used the sampling weights. The impact of shifting risk category on the total number of PGSI harms reported at time 1 and time 2 was examined in a split-plot two-way analysis of variance (ANOVA) with change in risk category (four levels: low risk at both times 1 and 2; low risk to high risk, high risk to low risk, high risk at times 1 and 2) being the between-group factor and time being the within-group factor. All statistical analyses were carried out with STATA 10.

RESULTS

Gambling above the low-risk limits and experiencing harm

Among the 809 LLLP participants followed over time, 9% reported harm (≥2 negative consequences from gambling) at time 1 and 14% reported harm at time 2. As shown in Table 2, gambling in the high-risk range for frequency, expenditure or percentage of income spent on gambling was associated with an eight- to 12-fold increase of experiencing harm compared to gamblers who stayed in the low-risk ranges. Although gambling in the high-risk range for total expenditures (>CAN$1000 per year) was associated with the largest increase in harm, there was considerable overlap of the OR confidence intervals. Using logistic regression, we predicted harm from gambling using status on each of the low-risk gambling limits as predictor variables. With all three risk limits in the model ($R^2 = 0.18$; Wald $\chi^2 = 78.26$; $P < 0.0001$), only gambling three times a month or more independently predicted harm [OR = 4.8, 95% confidence interval (CI): 2.2–10.5, $P < 0.001$].

The proportion of adults gambling in the high-risk range for at least one, two or all three categories was 23%, 9% and 5%, respectively. Using logistic regression modelling again, harm was predicted from the number of low-risk gambling limits the gambler was above (range 0–3). The overall model was significant ($R^2 = 0.18$; Wald $\chi^2 = 75.61$; $P < 0.0001$). For each additional low-risk limit exceeded, the odds of experiencing harm increased by a factor of 3.0 (95% CI: 2.3–3.7, $P < 0.0001$).

Change from time 1 to time 2 in gambling habits and low-risk status

Most gamblers (n = 393; 58%) were considered low risk at both times 1 and 2. About 19% (n = 181) of gamblers shifted from low risk to high risk and 6% (n = 53) shifted

Table 2 Gambling above the low-risk limits and experiencing harm[a] concurrently at time 1.

	Gamblers in risk category		*Gamblers not in risk category*		
Risk limit category	*n*	*Gamblers who report harm (%)*	*n*	*Gamblers who report harm (%)*	*Odds ratio[b] (95% CI)*
Spend more 1% income	142	43 (32.0%)	667	36 (5.6%)	8.0* (4.4–14.3)
Spend more than $1000/year	87	36 (42.7%)	722	43 (6.0%)	11.7* (6.3–21.6)
Gamble 3 times/month or more	168	48 (29.0%)	637	30 (4.5%)	8.6* (4.7–15.7)
High-risk on any limit	235	58 (25.9%)	574	20 (3.6%)	9.2* (4.9–17.2)

[a]Harm defined as endorsing at two or more consequences of problem gambling on Problem Gambling Severity Index (PGSI) as occurring sometimes, most of the time or almost always. [b]Odds of experiencing harm if gambler is in risk category compared to not being in risk category. *$P < 0.0001$. CI: confidence interval.

Table 3 Gambling above the risk limits at time 1 and time 2.

	Time 1		*Time 2*		
Low-risk gambling limit	*n*	*% (weighted)*	*n*	*% (weighted)*	*χ^2 (d.f.)*
>1% income	142	12.0%	248	23.4%	143.89* (1808)
>$1000/year	87	7.5%	193	18.1%	74.94* (1808)
>3 times/month	168	17.1%	226	20.7%	88.65* (1803)
Any risk limit	235	22.8%	363	35.5%	133.91* (1808)

*$P < 0.0001$.

from high risk to low risk between the assessment periods. The remaining 16% ($n = 184$) were considered high risk at both time-periods. A significant increase in higher-risk gambling was evident between time 1 and time 2. The proportion of adults gambling in the high-risk range increased significantly for all three dimensions of gambling intensity (frequency, total expenditures and percentage of income spent on gambling; data in Table 3). The use of EGMs also shifted between time-periods. At time 1, 33% of the sample played EGMs in the past year and this increased to 42% at time 2 ($\chi^2_{(1, 808)} = 128.28$; $P < 0.0001$). Similarly, the proportion of the sample who played casino games increased from 25% at time 1 to 29% at time 2 ($\chi^2_{(1, 808)} = 71.35$; $P < 0.0001$).

Gamblers who shift from low to high risk

Compared to gamblers who remained in the low-risk range for all categories at time 2, gamblers who were in at least one high-risk category at time 2 were 2.6 times (95% CI: 1.4–4.9) more likely to experience harm (7% versus 17%; $\chi^2_{(1, 570)} = 11.63$; $P < 0.001$). There was also a significant increase in the proportion who played EGMs, from 38% at time 1 to 50% at time 2 ($\chi^2_{(1, 570)} = 58.22$; $P < 0.0001$) and the proportion who played casino games, 23% at time 1 to 32% at time 2 ($\chi^2_{(1, 570)} = 18.99$; $P < 0.001$).

For gamblers who shifted from low to high risk on percentage of income spent on gambling, the proportion reporting harm was 3.5 times higher (95% CI: 1.9–6.3) than the proportion who remained low risk at both time-periods (23% versus 8%; $\chi^2_{(1, 666)} = 24.06$; $P < 0.0001$). Time 1 gamblers who shifted into the high-risk category for total expenditures (>$1000 per year) at time 2 were 2.6 times more likely (95% CI: 1.5–4.7) to experience harm compared to low-risk gamblers (22% versus 10%; $\chi^2_{(1, 666)} = 13.53$; $P < 0.0005$). A higher proportion of gamblers shifted from low to high risk on frequency of gambling reported harm (16%) compared to gamblers who remained low risk (10%); however, this difference was not statistically significant (OR = 1.8; $P = 0.07$).

Logistic regression modelling was used to predict change in gamblers from low risk to high risk (for any limit at time 2). As recommended by Hosmer & Lemeshow [22], we screened for potential predictor variables based on a bivariate association with change in risk category using a liberal criterion for significance ($P < 0.10$). Using this approach, the variables associated with change from low to high risk were age, gender, education, smoking status, marital status, parental gambling, percentage of friends who gamble regularly and time 1 EGM play. Variables not associated with change in risk category were time 1 casino play, income, ethnicity,

Table 4 Results of multivariate logistic regression predicting who shifts from low risk at time 1 to high risk at time 2 based on exceeding the low-risk gambling limits.

Independent variables in the model	*Remain low risk*	*Shifted from low to high risk*	*Odds ratio*	*95% CI*	*P*
Male (%)	41.4	56.4	2.3	1.4–3.7	<0.001
Age (mean years)	36.9	45.1	1.1	1.0–1.1	<0.001
No post-secondary education (%)	44.9	48.5	1.7	1.0–2.9	0.036
Marital status (% married)	40.1	52.4	1.2	0.7–1.9	0.52
EGM play at time 1 (%)	29.3	38.4	1.7	1.0–2.9	0.04
Parents gambled regularly (% yes)	20.3	30.7	1.7	0.9–2.9	0.06
Proportion of friends who gamble regularly (mean)	14.3	20.9	1.1	1.1–1.2	0.002
Smoker (%)	13.0	24.8	2.7	1.5–6.7	<0.001

EGM: electronic gaming machines; CI: confidence interval.

alcohol dependence, drug dependence, major depression and excitement seeking and impulsivity scores.

As shown in Table 4, the final model was significant and accounted for 13% of the variance in change in risk category (Wald $\chi^2 = 66.49$; $P < 0.0001$). Compared to gamblers who remain low risk, gamblers who shifted from low- to high-risk gambling were more likely to be male, older, have less education, have more friends who gamble, play EGMs at time 1 and smoke.

Gamblers who shift from high risk to low risk

The trajectory for gamblers who shifted from high risk at time 1 to low risk at time 2 was less conclusive. The proportion of gamblers reporting harm was lower (19%) in the group who became low risk compared to gamblers who remained high risk (32%); however, this difference was not statistically significant (OR = 2.0; 95% CI: 0.8–5.1; $P = 0.16$). The results for the individual low-risk limits were also non-significant, although the differences were all in the expected direction.

Impact of shifting risk level on total number of gambling harms

The two-way split-plot ANOVA conducted on total number of PGSI harms revealed a significant time × risk category interaction ($F_{(3, 805)} = 5.75$, $P < 0.001$), reflecting a significant change in the number of harms over time for some risk categories, but not others. Specifically, there was a reliable increase in the number of harms for gamblers who shifted from low risk to high risk ($t_{(174)} = 4.42$, $P < 0.001$). However, there was also a reliable increase in the number of harms for gamblers who remained in the low-risk group ($t_{(399)} = 3.79$, $P < 0.001$) and the high-risk group ($t_{(183)} = 3.82$, $P < 0.001$) for both time-periods. The change in harms for gamblers who shifted from high risk to low risk was not significant, $t_{(49)} = 0.68$, $P > 0.05$. Means shown in Figure 1.

DISCUSSION

Data from the LLLP provide supporting evidence for the validity of the low-risk gambling limits in predicting future harm. Adults who shifted from gambling in the low-risk range at time 1 to gambling in the high-risk range at time 2 were two to three times more likely to experience harm compared to gamblers who remained in the low-risk range at both time-periods. Future harm also coincided with an increased incidence of playing EGM and other casino games between times 1 and 2. Chances of harm increase threefold for each additional low-risk limit the gambler exceeds.

An interesting finding to emerge was the general progression in the LLLP sample towards more high-risk game choices and more gambling. From time 1 to time 2, the proportion of adults who shifted from low- to high-risk gambling levels increased 13% and the proportion who play EGMs increased 9%. Regular play of EGMs and casinos is associated more strongly with problem gambling than other forms of gambling [15–17]. The proportion of the sample who reported harm from gambling increased by 5% between times 1 and 2. Even gamblers classified as low risk at both assessment points reported an increase in the number of consequences from gambling, although the relative change was not as pronounced as gamblers who shifted from low to high risk.

Both the increase in gambling behaviour and the shift towards higher risk games over time is consistent with population trends in the last 10 years. Some researchers have proposed that social adaptation will also take place, which will lead to decreased gambling-related problems with prolonged exposure [23,24]. Consistent with this model, jurisdictions where prevalence studies have been

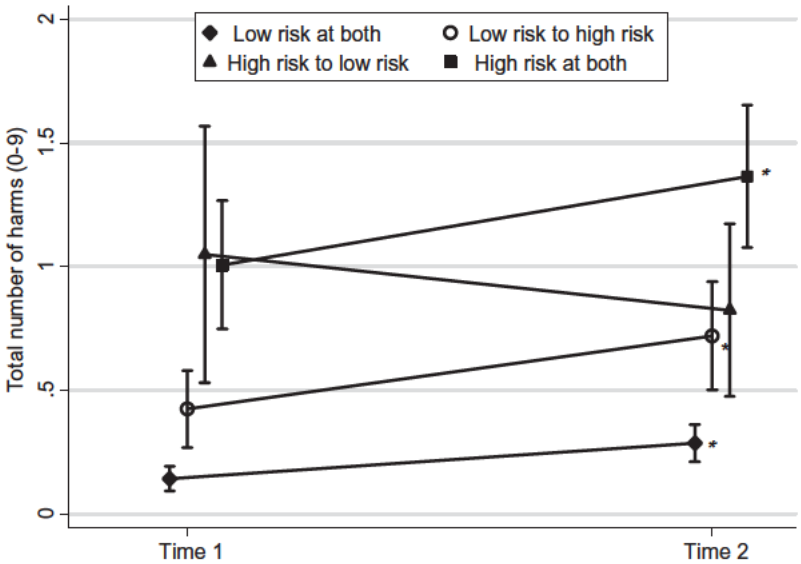

Figure 1 Change in total number of Problem Gambling Severity Index (PGSI)-assessed harms reported from time 1 to time 2 in relation to change in risk category defined by low-risk gambling limits. Means and 95% CI displayed. Significant change ($P < 0.05$) in total harms indicated by *

repeated over time have not found increases in problem gambling rates [23]. It is also noteworthy that most people gambling over the limits reported no harm based on our definition of endorsing two or more symptoms on the PGSI. Under-reporting of consequences is one possible explanation. Gamblers who exceed the limit may also experience consequences not covered by the PGSI. Finally, the harm from heavy gambling, similar to heavy drinking, may not appear for several years.

We acknowledge that the change in data collection modality between time 1 and time 2 may have contributed to the increase in gambling behaviour. The switch in modality was conducted to minimize costs and increase the longitudinal retention rate. Higher response rates to health-related surveys are evident when mixed-mode strategies are used [25,26]. Nonetheless, it is possible that participants were more comfortable with reporting gambling behaviour in the format that provided greater anonymity [27]. Although the switch to the web modality may have contributed, the escalation in the level of gambling observed is not surprising in light of several facts. First, the LLLP sample is limited to Alberta, a province with more opportunities to gamble, a younger population and higher personal income levels compared to other provinces [1]. Secondly, between time 1 (2006) and time 2 (2008), eight new casinos opened in the province, representing a 47% increase in the total number of casinos. Thirdly, the time 2 data collection was completed just prior to the global economic downturn in 2008. Between time 1 and time 2, Alberta was experiencing a period of relative prosperity compared to other provinces. Lastly, the LLLP study intentionally oversampled at-risk gamblers.

We also acknowledge the potential impact of dropouts on the trend towards higher-risk gambling in the LLLP sample. The profile of individuals who dropped out after time 1 was typical of problem gamblers (younger, male, higher PGSI score). If these individuals remained in the study the progression toward higher-risk gambling may have been more pronounced. Conversely, it is possible these individuals would have remained high risk at both time-periods or decreased their involvement in gambling over time, thereby attenuating this trend. Alternatively, the interval between assessment points may be too short for harm associated with high-risk gambling to show a meaningful reduction (e.g. financial problems could persist after the gambler reduces gambling). In fact, the slow pace of the reduction of negative consequences from gambling has been identified as a significant relapse risk among pathological gamblers who have quit gambling [28]. Without knowing the trajectory of these dropouts, it is impossible to estimate how their absence impacts our analysis of trends over time.

Our attempt to identify gambler characteristics associated with shifting from low- to high-risk gambling produced some novel findings. Risk factors associated historically with problem gambling were also associated with exceeding the low-risk gambling limits: male, having less education, more friends who gamble, smoking and playing EGMs. Because gambling problems exist on a continuum, it is not surprising that there is some overlap in risk factors for problem gambling and gambling above the low-risk thresholds. Other traditional risk factors for pathological gambling—e.g. comorbid depression and substance dependence and impulsivity traits—did not predict shifting from low to high risk. These risk factors may be more effective in identifying people who are vulnerable to progressing from high-risk to pathological gambling. Older individuals were more likely to shift from low risk at time 1 to high risk at time 2.

The higher rate of dropouts in younger people may have been a contributing factor to our age finding. In the LLLP sample, younger people were more likely to be classified as high risk at both time-periods and hence did not change.

In conclusion, these longitudinal data support the validity of our previously identified indicators of high-risk gambling. Moving into high-risk gambling over a 14-month period was associated with increased risk of harm. In contrast, a shift from high-risk gambling at time 1 to low-risk gambling at time 2 was not associated with a significant decrease in harms. Gambling-related harms appear to be slow to resolve after gambling behaviour becomes less risky. Future waves of the LLLP data will be useful in determining the longer-term implications of reducing risk.

Declarations of interest

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