

# Physical accessibility of gaming opportunity and its relationship to gaming involvement and problem gambling: A systematic review

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## Abstract

This paper presents the findings of a systematic search undertaken for the period January 1990 to June 2011 of references including original, empirical findings of the relationship between accessibility of electronic gaming machines and rates of gambling involvement, problem gambling, or gambling-related treatment seeking. Titles and abstracts of 2156 references were reviewed, yielding 39 references meeting inclusion criteria. The review has revealed that the relationships between the physical accessibility dimensions of proximity and density and gambling involvement and problem gambling are complex. Research is only beginning to elucidate these dimensions, and many questions and methodological challenges remain to be addressed. The strengths, limitations, and gaps in the literature are discussed, and recommendations are made for future research.

## Résumé

Cet article présente les résultats d'une recherche documentaire systématique, effectuée entre janvier 1990 et juin 2011, incluant des résultats empiriques initiaux qui portaient sur la relation entre l'accessibilité aux appareils de jeu électroniques et les taux de participation au jeu, le jeu compulsif ou la recherche de traitement lié au jeu. On a étudié les titres et les résumés de 2 156 références, parmi lesquelles 39 correspondaient aux critères d'inclusion. Cette recherche a révélé la complexité des relations entre les dimensions d'accessibilité physique, c'est-à-dire la proximité et la densité d'une part, et la participation au jeu et le jeu compulsif d'autre part. La recherche commence à peine à élucider ces dimensions et de nombreuses questions et problèmes méthodologiques demeurent en suspens. L'article discute des forces, des limitations et des lacunes de la littérature spécialisée et formule des recommandations pour de futurs travaux de recherche.

## Introduction

The proliferation of electronic gaming machines (EGMs) in both casinos and residential areas has generated considerable concern regarding the potential harms to communities in many countries, including the United Kingdom, the United States, Australia, New Zealand, and countries throughout Europe and Asia (Meyer, Hayer, & Griffiths, 2009). There is growing evidence of an association between the availability of EGMs (both in casinos and non-casino gaming venues (NCGVs)) and increased gambling involvement (e.g., expenditure, duration of play) and problem gambling rates in a region (e.g., Adams, Sullivan, Horton, Menna, & Guilmette, 2007; Pearce, Mason, Hiscock, & Day, 2008; Room, Turner, & Ialomiteanu, 1999; Rush, Veldhuizen, & Adlaf, 2007; Welte, Wiczorek, Barnes, & Tidwell, 2004). Abbott (2006), however, argues that there are complexities in this relationship, specifically in the context of discussing the evidence for adaptation to this gambling opportunity at individual, community, and societal levels. Nevertheless, international and localised prevalence studies conducted over decades suggest increased EGM gambling involvement and problem gambling in those jurisdictions with EGMs, through the establishment of casinos and NCGVs (e.g., Currie et al., 2006; Griffiths, 2010; Livingston & Woolley, 2007; Productivity Commission, 2010; Risbeck & Paulsson, 2009; Wardle et al., 2011). For example, in Australia, gambling on EGMs accounts for approximately 62% (AUD\$11.9 billion) of gambling expenditure: approximately 15% of regular (weekly or more often) EGM gamblers are problem gamblers, and a further 15% are moderate-risk gamblers (Productivity Commission, 2010). These figures are reflected in findings that between approximately 60% and 85% of problem gamblers identify EGMs as the activity most associated with their gambling problems (Productivity Commission, 2010). These figures are similar to the percentage of European and New Zealand problem gambling help-seekers who identify EGM gambling as the primary activity associated with their problematic gambling (average of approximately 60–75% of help-seekers) (Griffiths, 2010; Ministry of Health, 2008). In Sweden, EGM gambling was one of three activities associated with significantly increased odds (OR 2.2) of problem gambling (the others were internet gambling [O.R. 2.3] and bingo [OR 2.2]) (Risbeck & Paulsson, 2009). In Canada, EGM gambling is the most popular gambling activity among problem gamblers, with over half gambling on non-casino gaming machines (NCGMs) and approximately 20% on machines in casinos. Significantly more problem gamblers gamble on EGMs fortnightly or more often, than any other group of problem gambling severity (Currie et al., 2006). In Britain, the reported figures are comparatively modest; with approximately 8% of at least monthly EGM gamblers and approximately 4% of past-year gamblers classified as problem gamblers (Wardle et al., 2011). In California, where EGMs are only available in casinos, problem gamblers are less likely to gamble on EGMs and report preferring card table games (Volberg, Nysse-Carris, & Gerstein, 2006). These few examples demonstrate the growing evidence that EGMs pose greater risk of problem gambling related harms than other forms of gambling.

It has been suggested that EGM gambling has an unequal impact on disadvantaged communities (Lam & Mizerski, 2009). Evidence suggests that gaming venues are usually disproportionately placed in neighbourhoods of lower socioeconomic status (SES) (Delfabbro, 2002; Diamond, 2009; Doughney, 2002; Fung & Wilkes, 1998). Thus, availability, motivation, and SES potentially interact with each other on gambling involvement and severity. In recognition of this, studies investigating these issues have attempted to account for their confounding effects in their study design or analysis. Researchers have also proposed theoretical frameworks to guide the conceptualisation and empirical investigation of the relationship between availability of gambling opportunities and gambling involvement and problems (LaPlante & Shaffer, 2007).

One theoretical framework from which to examine the impact of physical accessibility on gambling and problem gambling rates is the application of the *regional exposure theory*, which links physical accessibility, behavioural response, and subsequent impacts (LaPlante & Shaffer, 2007). Shaffer, LaBrie, and LaPlante (2004) argued that social activities such as gambling have a “toxic” effect and could be identified as a social toxin, analogous to a pathogen. Following McGuire’s (1964) theory of social inoculation, LaPlante and Shaffer (2007) argued that “... a social phenomenon, like exposure to toxins, can stimulate a shift in attitudes and behaviour; in turn, these changes can influence many things including health. The extent of those shifts depends on individuals’ ‘social immunity’ or resistance to the social phenomena that they have developed over time through exposure to the toxin” (p. 617).

Defining exposure in occupational, spatial, and temporal terms, LaPlante and Shaffer (2007) hypothesised three predictable effects of exposure to gambling. First, gambling service employees would have a higher incidence of gambling-related problems due to their regular contact with gambling products and gamblers. This prediction has been confirmed in empirical research (Guttentag, Harrigan, & Smith, 2011; Hing & Nisbet, 2009; Shaffer & Hall, 2002; Shaffer, Vander Bilt, & Hall, 1999). Second, changes in temporal (exposure over time) and spatial (gambling opportunities closer to home) factors would result in increases in gambling participation and a clustering of gambling-related problems near temporal and geographic epicentres of gambling. Third, if gambling acts like other threats to public health, we could expect to see gambling-related problems follow normal epidemiological curves, showing a sharp increase in early exposure followed by a levelling out or gradual reduction in problems as a result of the process of adaptation (LaPlante & Shaffer, 2007). An indication of support for the second and third effects has come from prevalence studies in Nevada. While prevalence rates were higher than in other jurisdictions, the relationship over time was shown to be curvilinear. The authors argued that this may be explained by a process of adaptation, that is, that residents of Nevada have been exposed for so long to gambling opportunities that these products no longer have the impact that they did when they were introduced (LaPlante & Shaffer, 2007). A study by Volberg (2002)

supports this notion with the finding that newly arrived residents to Nevada had a higher prevalence of current gambling problems than long-time residents (as they have experienced less exposure to gambling opportunities). Other studies have provided additional support for this theory of exposure and adaptation (Jacques & Ladouceur, 2006; LaBrie et al., 2007).

An examination of expenditure on EGMs in the Australian states and territories and in New Zealand in the late 1990s and their relationship to problem gambling rates suggests a positive linear relationship. However, over time, the relationships between involvement and problem gambling and also exposure (e.g., number of EGMs per 1,000 adults) and problem gambling appear to be non-linear, where engagement plateaus or declines over time. The author suggested that this provided evidence of exposure and adaptation theory (Abbott, 2006). There are, however, some limitations in comparing these studies. The data examined were of cross-sectional studies and at the relatively gross state or nation level of involvement and problem gambling and did not take into account possible confounding variables such as sociodemographic risk factors (e.g., income, ethnicity, access to alternative forms of entertainment). Differences in data collection methods and scales and problem gambling scoring methods used also make comparison between studies somewhat problematic. These findings, while useful indicators of relationships, are not sufficient evidence of an effect of physical accessibility of EGMs in a region on gambling involvement and problem gambling rates. Multiple dimensions of physical accessibility have been proposed, and a number of studies have applied more sensitive methods of analysis of the relationships between behaviours and physical accessibility, and various potentially confounding factors. It appears, however, that no systematic review of studies that aimed to empirically examine these relationships has been published to date.

In attempting to define and operationalise *exposure* or *accessibility*, different perspectives have been proposed. Hing and Nisbet (2010) identified three accessibility dimensions: (a) social accessibility, (b) cognitive accessibility, and (c) physical accessibility. Social accessibility included familiarity with the venue and positive gambling attitudes of co-workers (at the same venue or nearby venues) and patrons. Cognitive accessibility included “insider” knowledge of odds and jackpots and curiosity about competing venues’ offers. Physical accessibility included convenience and proximity and working split shifts and shiftwork (which had a preventative effect for some because the venue closed when their shift ended, but risk for those with no alternative activity outside of normal business hours). Employees working split shifts were particularly vulnerable because gambling opportunities were more readily available between shifts than alternative activities. Those workers who perceived their colleagues to have a positive attitude towards gambling and who considered themselves knowledgeable about the game (often because they worked in close proximity with customers while gambling) were likely to be more vulnerable. The authors note that while physical access to gambling opportunities is necessary for gambling involvement,

they stressed the importance of social and cognitive accessibility in determining involvement.

Hing and Haw (2009) developed an accessibility scale based on interviews with venue staff in Victoria, Australia, that are consistent with these dimensions (Hing & Breen, 2006) and the dimensions of physical accessibility listed by the Productivity Commission (2010). They reported that among Victorian venue workers, social acceptability had little influence on gambling behaviour, but knowledge about how to gamble on a certain activity increased expenditure and frequency of gambling on the given activity. Problem gambling was only associated with physical accessibility of sports betting opportunities. This provides some insight into the complexity of investigating the associations between gambling accessibility and involvement, expenditure, and problem gambling. Nevertheless, overall, social and cognitive factors have received little attention as dimensions of accessibility.

Australia's Productivity Commission (2010) proposed a list of dimensions of physical accessibility, which, ideally, would all be observed when examining associations between physical accessibility of gambling opportunities, gambling involvement, and problem gambling, to ensure reliability and validity of the construct. The listed dimensions included proximity to a venue, density of outlets and products (EGMs per head of population), distribution of products near or in locations regularly attended by the community (e.g., shopping centres, sports clubs, housing), hours of operation, forced breaks in play, initial outlay or cost, ease of use, and social acceptability. Physical accessibility, defined as proximity to venues and density of venues or EGMs, has been examined in population studies more often as possibly informing governments about the potential efficacy of supply reduction initiatives (Blaszczynski, 2001; Delfabbro, 2008; Dickson-Gillespie, Ruge, Rosenthal, & Fong, 2008; Williams, West, & Simpson, 2007). Supply reduction strategies intend to achieve social and health benefits by reducing the availability of gambling products. Supply is addressed in most jurisdictions in Australia, for example through mandating a maximum number of gaming venues in a defined area such as a local government region, or mandating a maximum number of EGMs in total at the state level, and the number of EGMs permitted per venue (Department of Families, Housing, Community Services and Indigenous Affairs, 2008). Supply-side strategies are also addressed in arguments for destination gaming, or the concentration rather than dispersal of gambling opportunity (Victorian Department of Justice, 2008).

Comparison and interpretation of findings related to accessibility, involvement, and problem gambling are complicated by a number of factors, including: (a) different methodologies in data collection; (b) differing units and parameters of measurement and analysis; (c) difficulties in matching "control" regions according to sociodemographic factors; (d) changes over time within a community, licensing, venues, and products; and (e) possible confounding factors, such as accessibility of other gambling products, SES of the surrounding area, proportion of certain ethnic groups that may be more vulnerable

to problem gambling (such as recently arrived refugees), and venue proximity to other entertainment venues and to places of regular social congregation (such as shopping centres, schools, and licensed venues).

The question of the proximity and density of gambling opportunity (i.e., physical accessibility) and their relationship to gambling involvement and problem gambling is now being addressed both as a theoretical issue and as a policy issue, but to date there has been no systematic review of the evidence about this relationship. The present study attempts to address this gap.

## **Method**

A systematic review of the literature addressing the relationship between EGMs and venue proximity, venue density, rates of gambling participation, expenditure, problem gambling, and gambling-related help-seeking was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement (Moher, Liberati, Tetzlaff, & Altman, 2009). The PRISMA Statement aims to standardise and encourage best practice in the conduct of systematic and meta-analytic reviews. The Statement was born of a review of the Quality of Reporting of Meta-analyses (QUOROM) Statement, which led to updated and more detailed instructions for the conduct and reporting of systematic reviews (in addition to meta-analyses). A detailed and clear checklist of items guides the conceptual and practical processes to be undertaken for reviews. The Statement was developed primarily for the review of clinical trials; however, the authors endorse modification according to the nature of the studies under review (Moher et al., 2009). A principal tenet of the PRISMA Statement is transparency of each step undertaken by the review team. The PRISMA Statement and supporting documents are available through open access online. More than 170 health sciences journals and organisations (PRISMA, 2012), including the Cochrane Collaboration, endorse the PRISMA Statement (Higgins & Green, 2011). The present authors have aimed to provide a clear and detailed explanation of their procedure of literature collection and review. The procedure for systematic reviews was adhered to in all respects. The systematic literature search was conducted in May 2011 of the following resources: (a) academic electronic databases, and (b) the websites of Australian, Canadian, US, and New Zealand organisations and government departments responsible for gambling research and policy.

### **Search strategy**

Boolean searches were conducted in Expanded Academic ASAP, and multi-database Boolean searches were conducted in EBSCOhost (21 databases), CSA Illumina (8 databases), and JSTOR. The following terms were searched in each database: density, accessibility, proximity, distribution, cap, mapping, machine placement, geographic information systems, help-seeking, treatment, and regulation. In order to narrow search results to references that report on gaming machines,

each search term was combined in an algorithm where either “electronic gaming machine” or “video lottery terminal” or “pokies” or “casino” or “problem gambling” or “pathological gambling” was present in the article. The search mode permitted the terms to be found anywhere in the article, including keywords, title, abstract, and full text. The searches were limited to English-language scholarly articles of peer-reviewed journals that were published from January 1990 onwards. The references were exported into an EndNote X3 library, and duplicates were identified and removed using the EndNote duplicates search function. This search yielded 2046 articles to be retained for examination of eligibility for inclusion in the review.

A substantial amount of the research conducted into gaming machine availability and problem gambling is conducted by research centres and government departments, and the results of these studies are often not published in peer-reviewed journals. Consequently, it was thought important to include this material, often called *grey literature*, in the search process. Searches were conducted using the online library search functions of the following organisations: Alberta Gaming Research Institute, Australasian Gaming Council, Gambling Research Australia, Independent Gambling Authority South Australia, Victorian Department of Justice Office of Gaming and Racing, The Responsible Gambling Council (Ontario), The Problem Gambling Foundation of New Zealand, and the New Zealand Ministry of Health. The search functionality of these websites was more limited than that of the academic databases; therefore, a reduced number of search terms were used. The term “electronic gaming machine” was searched in all libraries. Where hundreds of reports were returned, the terms “accessibility”, “density”, “proximity”, and “distribution” were also included with OR commands. The references were entered into an EndNote X3 library, and duplicates were identified and removed using the EndNote duplicates search function. This process resulted in 81 papers for examination of eligibility for inclusion in the review.

Hand searches were conducted on the reference lists of key studies identified following examination of their abstracts and/or full text. Documents were included for examination if they referred to numbers or proximity of gaming machines in the title. This method identified an additional 29 studies for examination of eligibility for inclusion in the review.

### **Inclusion and exclusion criteria**

Once the EndNote library had been cleared of duplicates, titles and abstracts of each reference were read to assess whether it met the criteria for inclusion. References were included if they reported original, empirical findings of the relationship between the physical accessibility of gaming machines and rates of gambling involvement, problem gambling, or gambling-related treatment-seeking in the community.

References were excluded if they were editorial or review papers; did not report results of an empirical analysis of a relationship between availability of gaming machines, and gambling involvement or problem gambling rates; or did not sample a cross-section of the community (e.g., used a prison sample). If two or more papers reported findings from the same sample, the paper that reported less salient findings or provided less detail about methods was excluded. However, if each provided unique findings, both were included.

The titles and abstracts of 2156 references were reviewed, and 110 were included (2046 excluded) for further examination as they appeared to meet the above criteria for inclusion. Full-text examination of the 110 references revealed 39 references that met the criteria for inclusion in the review.

### **Data extraction**

Two authors independently evaluated and extracted the data. The accuracy of extraction of each study was assessed against the original document by a third author.

The following data were extracted from included studies: (a) study characteristics, including the jurisdiction where data were collected and sample size; (b) methodological design, including measurement instruments, data sources, and study design; (c) statistical analysis employed; and (d) statistical data related to the association between accessibility to EGMs and gambling involvement (including expenditure, frequency of gambling, and money and time spent gambling), problem gambling, or help-seeking.

### **Results**

A summary of the 39 included studies is presented in Table 1. The studies present findings from Australia, Canada, New Zealand, Norway, and the United States. Twenty-five peer-reviewed articles; eleven provincial, state, or federal government reports; two local government reports; and one book chapter met criteria for inclusion. Twenty-five studies conducted archival analysis, seven of which also collected survey data. Operational definitions of factors such as access, proximity, density, and problem gambling vary considerably between studies, as do analytic methods, varying from econometrics to regressions to descriptive statistics.

The findings of the studies were synthesised into the following thematic groupings: proximity of gaming venues, density of gaming products, the introduction of new gaming venues, and changes to opening hours. Based on the major issues identified in previous research, these themes are discussed in terms of physical accessibility, EGM involvement, problem gambling severity, and SES. The studies' methods, analyses, and findings are compared and critiqued, and suggestions for future research directions are outlined.

Table 1  
*Summary of the 39 Studies on Physical Accessibility of Gaming Opportunity's relationship with Gaming Involvement and Problem Gambling*

Authors	Jurisdiction	Sample	Analysis	Findings
Adams et al. (2007)†	Ontario, Canada	1579 students of 4 universities located near a casino	Chi-square	<ul style="list-style-type: none"> <li>Significantly more students who studied near a casino than those who studied far from a casino gambled on casino slots (55.3% vs 29.1%, <math>p &lt; .001</math>).</li> <li>Pathological gamblers were significantly more likely to attend universities close to a casino than distant from a casino (80% vs 20%, <math>p &lt; .001</math>).</li> </ul>
Corporate Research Associates Inc. (2006)*	Nova Scotia, Canada	Surveys with 2,121 residents who had gambled on VLTs in the last 12 months	Frequency distributions	<ul style="list-style-type: none"> <li>The study reported on reductions in gambling involvement following the removal of approximately 30% of the province's VLTs.</li> <li>12% decreased their VLT gambling: 57% problem gamblers, 43% moderate-risk gamblers, 25% at-risk gamblers, and 13% non-problem gamblers.</li> <li>Spending decreased by an average of 30% (CAD\$146) for problem gamblers, 19% (CAD\$62) for moderate-risk gamblers, 17% (CAD\$46) for at-risk gamblers, and 7% (CAD\$37) for non-problem gamblers.</li> <li>11% decreased the time they spent gambling on VLTs in a week: 22% problem gamblers, 25% moderate-risk gamblers, 17% at-risk gamblers, and 6% non-problem gamblers.</li> <li>The average number of fewer minutes spent gambling was 199 for problem gamblers, 69 for moderate-risk gamblers, 26 for at-risk gamblers, and 15 for non-problem gamblers.</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
Delfabbro, P. H. (2002)*	Adelaide, Australia	Not applicable	<ul style="list-style-type: none"> <li>• Descriptive statistics</li> <li>• Correlations</li> <li>• Hierarchical regressions</li> </ul>	<ul style="list-style-type: none"> <li>• Socioeconomic disadvantage was associated with gambling-related losses (<math>r = 0.32, p &lt; 0.05</math>).</li> <li>• The most significant factor influencing net losses was density of EGMs (<math>t = 11.33</math>; model: Adj. <math>R^2 = 0.55</math>; <math>F(6, 44) = 26.44, p &lt; .001</math>).</li> <li>• There was a significant positive correlation between EGM numbers and (a) the number of first-time presentations to break even (<math>r = 0.39, p &lt; .01</math>) and (b) problem gambling (<math>r = 0.32, p &lt; .05</math>).</li> <li>• There was no significant association between EGM numbers and problem gambling when demographic factors were excluded.</li> </ul>
Delfabbro, P. (2008)†	South Australia, Australia	594 venues and 400 gaming machine players	ANOVA and correlation analysis	<ul style="list-style-type: none"> <li>• Net gambling revenue [<math>F(1506) = 30.40, p &lt; .01</math>] and the amount spent on each machine [<math>F(1506) = 419.20, p &lt; .01</math>] were significantly higher after the removal of machines.</li> <li>• Of 400 gamblers, only 30 reported that they changed their gambling behaviours after the removal of machines.</li> <li>• Of gamblers who had a hard time finding machines after the removal, only 2% reported that it helped control their gambling.</li> <li>• Gamblers who felt they had fewer opportunities to gamble were more likely to feel that their urge to gamble decreased (<math>r = .61, p &lt; .01</math>) and that they were in control of their expenditure (<math>r = .54, p &lt; .01</math>).</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
Diamond, N. (2009)*	Victoria, Australia	Archival data for 52 local government areas (LGAs)	<ul style="list-style-type: none"> <li>Hierarchical linear regression</li> <li>Time series plots</li> <li>Spline interpolation</li> </ul>	<ul style="list-style-type: none"> <li>The average daily per capita expenditure was higher in more disadvantaged LGAs.</li> <li>The average daily per capita expenditure was higher in LGAs with a higher concentration of EGMs.</li> <li>There was no reported quantification of the per capita relationships.</li> <li>The model described 90% of the variance in 41 of the 52 data sets (LGAs).</li> </ul>
Doughney, J. (2002)#	Victoria	Archival data of state and LGAs	<ul style="list-style-type: none"> <li>Descriptive statistics</li> <li>t-tests</li> <li>Linear regression</li> </ul>	<ul style="list-style-type: none"> <li>3 of the most disadvantaged LGAs had the highest density of EGMs per adult.</li> <li>LGAs with the least spend per adult on EGMs had the lowest number of EGMs and higher SES.</li> <li>Regression coefficients, <math>r</math> squared, and <math>p</math> values not reported.</li> </ul>
Doran, B., & Young, M. (2010)†	Northern Territory, Australia	Not applicable	<ul style="list-style-type: none"> <li>Descriptive statistics</li> <li>Gravity models</li> <li>Geographically coded locations</li> </ul>	<ul style="list-style-type: none"> <li>High availability of gaming venues increased the vulnerability of residents beyond that explained by the SEIFA Index of Disadvantage.</li> <li>No statistics were reported.</li> </ul>
Doran et al. (2007)†	Tuggeranong Valley, Canberra, Australia	Door-to-door survey of adult residents ( $n = 2447$ )	<ul style="list-style-type: none"> <li>Geographically coded locations</li> <li>Kernel densities</li> </ul>	<ul style="list-style-type: none"> <li>Venues located near (<math>&lt; 0.5</math> km) large areas of community congregation (e.g., churches, shops, or schools) have larger catchment areas than those more isolated.</li> <li>High-density EGM venues had catchments that were more extensive.</li> <li>The results suggest that venues vary in catchment size.</li> <li>No statistics were reported.</li> </ul>

Table 1  
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Authors	Jurisdiction	Sample	Analysis	Findings
Frankston City Council. (2000)	Frankston City, Victoria, Australia	Frankston City adult residents ( $n = 300$ )	Descriptive statistics	<ul style="list-style-type: none"> <li>• 35.7% of participants gambled on EGMs only in Frankston, 25.9% gambled elsewhere, and 38.4% gambled both in Frankston and elsewhere.</li> <li>• Distance from a venue (% residents): &gt; 5 km: 5.6%; 1–5 km: 54%; &lt; 1 km: 38%.</li> </ul>
Gerstein et al. (1999)*	8 states in United States	Community adult sample $N = 2947$	Descriptive statistics	<ul style="list-style-type: none"> <li>• Problem and pathological gambling rates in regions within 50 miles of a casino were double those of regions within 50 to 250 miles.</li> </ul>
Gilliland, J., & Ross, N. (2005)†	Montreal and Laval, Quebec, Canada	Archival data for venues with VLTs ( $n = 834$ ) and boroughs ( $n = 49$ )	<ul style="list-style-type: none"> <li>• Correlations</li> <li>• Bi-variation regressions</li> </ul>	<ul style="list-style-type: none"> <li>• VLT use prevalence, adoption, and density were significantly positively correlated with rates of unemployment, low high school completion, and single-parent families (<math>p &lt; 0.01</math>).</li> <li>• Low education levels alone accounted for 50% of the variation in the rate of adoption of VLTs.</li> </ul>
Govoni et al. (1998)†	Windsor, Ontario, Canada	2082 adult residents pre- and 2581 adults 1-year post-casino opening	<ul style="list-style-type: none"> <li>• Mann–Whitney U</li> <li>• Kolmogorov–Smirnov 2-sample test</li> </ul>	<ul style="list-style-type: none"> <li>• No statistically significant change in problem gambling or expenditure rates occurred 1 year after the opening of a casino.</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
Hing, N., & Nisbet, S. (2009)*	Victoria, Australia	<ul style="list-style-type: none"> <li>Gaming venue staff</li> <li>Survey (<math>n = 533</math>) and telephone interviews (<math>n = 40</math>)</li> </ul>	<ul style="list-style-type: none"> <li>Descriptive statistics</li> <li>Logistic regression</li> <li>Thematic analysis</li> </ul>	<p><i>Quantitative findings:</i></p> <ul style="list-style-type: none"> <li>20% increased their gambling since working in a gaming venue.</li> <li>Venue staff gambling participation rate (95.9%) was higher than in the Victoria population (77.4%).</li> <li>Problem gamblers: 5.6%; moderate-risk gamblers: 13.7% (vs Vic: 0.97 and 0.91 respectively).</li> <li>Gambling participation and cognitive access to EGMs 'extremely easy': 83%; 'somewhat difficult': 49%.</li> </ul> <p><i>Qualitative findings:</i></p> <ul style="list-style-type: none"> <li>Accessibility themes included convenience, familiarity, comfort and security of gambling in the work-place, and enhanced knowledge of gambling odds.</li> </ul>
Jacques, C., & Ladouceur, R. (2006)†	Quebec, Canada	<ul style="list-style-type: none"> <li>810 adults living near a casino</li> <li>798 adults not living near a casino</li> <li>Pretest, 1-, 2- &amp; 4-year follow-up</li> </ul>	<ul style="list-style-type: none"> <li>Repeated measures GLM</li> <li>Chi-square</li> <li>Satterthwaite F Tests</li> </ul>	<ul style="list-style-type: none"> <li>Participants living near the casino reported higher levels of gambling participation (<math>F = 76.66</math>, <math>p &lt; .01</math>) and expenditure (<math>F = 20.92</math>, <math>p &lt; .01</math>) than participants in the control city.</li> <li>The maximum amount of money lost in a day by respondents increased from baseline to 4-year follow-up (<math>F = 66.10</math>, <math>p &lt; .01</math>) for participants living near the casino.</li> <li>Participants living near the casino had higher SOGS score (<math>F = 15.04</math>, <math>p &lt; .01</math>) compared to participants living in Quebec City and sustained at 4-year follow-up (<math>\chi^2 = 13.68</math>, <math>df = 1</math>, <math>n = 428</math>, <math>p &lt; .01</math>).</li> </ul>

Table 1  
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Authors	Jurisdiction	Sample	Analysis	Findings
Jacques et al. (2000) <sup>†</sup>	Quebec, Canada	<ul style="list-style-type: none"> <li>• 810 adults living near a casino</li> <li>• 798 adults not living near a casino</li> </ul>	<ul style="list-style-type: none"> <li>• Repeated measures ANOVA</li> <li>• Nonparametric repeated measures ANOVAs</li> </ul>	<ul style="list-style-type: none"> <li>• Proximity to a casino was associated with more frequent gambling (<math>F = 52.34, p &lt; .01</math>) and expenditure (<math>F = 34.61, p &lt; .01</math>).</li> <li>• Significantly higher problem gambling rates (<math>\chi^2 = 4.90, df = 1, n = 879, p &lt; .05</math>) and lifetime severity (<math>\chi^2 = 7.58, df = 1, n = 864, p &lt; .01</math>) were associated with proximity to a casino.</li> </ul>
Lund, I. (2009) <sup>†</sup>	Norway	Residents surveyed before and after a ban on EGM gaming ( $n = 1293$ )	<ul style="list-style-type: none"> <li>• Descriptive statistics</li> <li>• McNemar test for related samples</li> <li>• ANOVA</li> </ul>	<ul style="list-style-type: none"> <li>• There were significant reductions in the prevalence of gambling problems (1% to 0.4%, <math>p &lt; 0.05</math>) and lying and chasing (1.5% to 0.8%, <math>p &lt; 0.05</math>), but no significant change in betting and at-risk gambling after the EGMs disappeared.</li> <li>• For the sample as a whole, total participation dropped from 97% to 78.2%, and participation was significantly reduced in all types of gambling except bingo automats, where there was no significant change.</li> <li>• Highly at-risk gamblers reduced their total gambling from 100% to 82.8%, <math>p &lt; 0.001</math>.</li> <li>• There was no significant change in frequency of playing non-EGM participation for low- and high-intensity gamblers, whereas at-risk gamblers fell from 41.3% to 33%, <math>p &lt; 0.05</math>.</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
McMillen, J., & Doran, B. (2006) <sup>†</sup>	Victoria, Australia	Archival data for LGAs	<ul style="list-style-type: none"> <li>• Kernel density functions</li> <li>• Time series</li> </ul>	<ul style="list-style-type: none"> <li>• There was no consistent relationship between increased intensity of EGM expenditure and 'clusters' of venues.</li> <li>• There were annual and seasonal fluctuations in EGM expenditure patterns across all the study localities.</li> <li>• No statistic was reported.</li> </ul>
Marshall, D. (2005) <sup>†</sup>	Richmond-Tweed, New South Wales, Australia	Face-to-face survey of adults ( $n = 1018$ )	Linear regressions	<ul style="list-style-type: none"> <li>• The centres with the greatest per capita concentrations of EGMs also tended to have the highest EGM participation rates (previous 6 months: <math>R^2 = 0.709</math>, <math>p = 0.017</math>; previous week: <math>R^2 = 0.729</math>, <math>p = 0.0144</math>).</li> </ul>
Marshall, D., & Baker, R. (2002) <sup>†</sup>	Melbourne & Sydney, Australia	<ul style="list-style-type: none"> <li>• Melbourne: 30 LGAs</li> <li>• Sydney: 44 LGAs</li> <li>• Observations: 1993 to 1998</li> </ul>	Time-series analysis	<ul style="list-style-type: none"> <li>• Melbourne: EGMs were increasingly in lower SES LGAs (1994: <math>R^2 = 0.23</math>; 1998: <math>R^2 = 0.60</math>).</li> <li>• Melbourne: EGM density was correlated with expenditure per person (<math>R^2 = 0.817</math>).</li> <li>• There was a similar association between EGM density and SES for both cities despite differences in the period of community exposure (Melbourne 1998: <math>y = 166.026 - 0.279 * X + 1.201E-4 * \chi^2</math>, <math>R^2 = 0.60</math>; Sydney 1998: <math>y = -63.79 + 0.186 * X - 1.075E-4 * \chi^2</math>, <math>R^2 = 0.50</math>).</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
Marshall et al. (2004)*	Tuggeranong Valley, Canberra, Australia	Door-to-door survey of adult residents ( <i>n</i> = 2447)	<ul style="list-style-type: none"> <li>• Descriptive statistics</li> <li>• Geographically coded venues</li> </ul>	<ul style="list-style-type: none"> <li>• Proximity to a regular club (&lt; 3.54 km) was associated with more annual spend (\$1,858 vs \$580).</li> <li>• There were few differences in EGM gambling across different income groups.</li> <li>• Club catchments show a high degree of overlap with the nearby most disadvantaged suburbs.</li> <li>• There was little overlap between clubs that draw clients from more advantaged areas in the near vicinity.</li> </ul>
Mason, K. (2006)*	New Zealand	<ul style="list-style-type: none"> <li>• 6 casinos</li> <li>• 2121 gaming venues</li> <li>• 579 TABs</li> <li>• 22,417 EGMs</li> </ul>	<ul style="list-style-type: none"> <li>• Descriptive statistics</li> <li>• Spatial analysis</li> </ul>	<ul style="list-style-type: none"> <li>• 33.7% of NCGMs and 30.4% of NCGM venues were in the 2 most deprived SES deciles, compared with 5.3% and 6.4%, respectively, in the 2 least deprived deciles.</li> <li>• At-risk populations, in particular Maori and Pacific peoples, were over-represented in more deprived areas.</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
Mason, K. (2008)*	New Zealand	<ul style="list-style-type: none"> <li>• 6 casinos</li> <li>• 2121 gaming venues</li> <li>• 579 TABs</li> <li>• 22,417 EGMs</li> </ul>	<ul style="list-style-type: none"> <li>• Multilevel logistic regression</li> <li>• Geographically coded locations</li> </ul>	<ul style="list-style-type: none"> <li>• Proximity to NCGVs significantly increased likelihood to have gambled on an NCGM in the last year, even after taking into account sociodemographic factors (<math>&lt; 734</math> m: OR 1.67, <math>p &lt; .05</math>; 734–1316 m: OR 1.72, <math>p &lt; .05</math>), and be a problem gambler who had gambled on an NCGM (<math>&lt; 734</math> m: OR 2.71, <math>p &lt; .05</math>; 734–1316 m: OR 2.82, <math>p &lt; .05</math>).</li> <li>• 44 or more venues within 5 km of a neighbourhood centre significantly increased the likelihood of gambling at a venue in the past year (OR 1.67, CI 1.25–2.23, <math>p &lt; .05</math>).</li> <li>• 448 or more NCGMs within 5 km of a neighbourhood centre increased the likelihood of gambling on a NCGM in the past year, but not significantly (OR 1.30, CI 0.91–1.85, <math>p &gt; .05</math>).</li> </ul>
O'Neil et al. (2005)*	Victoria, Australia	<ul style="list-style-type: none"> <li>• LGAs with reduction ('cap') in EGMs (<math>n = 5</math>) and no reduction (<math>n = 5</math>)</li> <li>• 188 venues</li> <li>• 10,655 monthly venue observations</li> </ul>	<ul style="list-style-type: none"> <li>• Regression analysis</li> </ul>	<ul style="list-style-type: none"> <li>• Significant reductions in expenditure 3 years post EGM cap for 2 LGAs (9.9% and 17.5% reduction), but not at the venue level, and reductions consistent with state gaming expenditure reductions.</li> <li>• A 1% reduction in EGM numbers was associated with a 0.2% reduction in expenditure (<math>p &lt; .05</math>).</li> <li>• Decline in help-seeking was consistent across the state (418 to 230 persons); 2% reduction in calls to helpline specifically for gambling problems.</li> <li>• Venue owners/local managers reported in interviews that removal of machines had little impact because previously idle machines were taken up.</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
Pearce et al. (2008) <sup>†</sup>	New Zealand	<ul style="list-style-type: none"> <li>• 12,529 adults</li> <li>• NCGM venues, TABs, and casinos</li> <li>• 38,350 census meshblocks (average population 100)</li> </ul>	2-level logistic regression models	<ul style="list-style-type: none"> <li>• Linear relationship between neighbourhood deprivation and proportion of EGM gamblers (high deprivation: 45.9%; low deprivation: 9.9%) and problem gamblers (high deprivation: 56%; low deprivation: 5.4%).</li> <li>• Proximity to NCGM venues significantly increased odds (OR 2.70, 95% CI 1.03–7.05) of being a problem gambler after adjusting for metro area, deprivation, and demographics.</li> <li>• High gaming venue density was associated with significantly increased odds of gambling (OR 1.67, 95% CI 1.25–2.23, <math>p &lt; .05</math>) but not problem gambling.</li> </ul>
Productivity Commission (1999)*	Australia	<ul style="list-style-type: none"> <li>• 10,500 adults</li> <li>• Multiple data sets from across Australia</li> </ul>	Synthesis of comprehensive data mining	<ul style="list-style-type: none"> <li>• Gambling expenditure has grown most rapidly in those states which have legalised or liberalised access to gaming machines.</li> <li>• Introduction of EGMs in Western Australia, matching the eastern states, would lead to an additional 10,500 (approx. 110%) more problem gamblers.</li> <li>• Low machine density: 10% increase in EGMs would result in approximately a 7.5% increase in help-seeking.</li> <li>• High machine density: 10% increase in EGMs would result in approximately a 9.4% increase in help-seeking.</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
Productivity Commission (2010)*	Australia	Not applicable	<ul style="list-style-type: none"> <li>• Collation of data from different sources</li> <li>• Re-analysis of spend and density</li> </ul>	<ul style="list-style-type: none"> <li>• The number of clients who reported problems with EGMs was much lower in Western Australia (22%), where access to gaming machines was confined to the casino, compared to New South Wales, Victoria, the Northern Territory, and the ACT (74% to 79%).</li> <li>• There was a positive relationship between gaming machine density and gambling expenditure per adult (estimated EGM values, <math>R^2 = 0.5981</math>; actual EGM values, <math>R^2 = 0.4354</math>).</li> <li>• No statistical <math>p</math> values were reported.</li> <li>• Casino gambling in Niagara Falls increased significantly (approx. 10% vs 45%) [<math>\chi^2(1, n = 1753) = 191.7, p &lt; 0.01</math>] as did the Ontario population, but to a lesser extent (approx. 10% vs 20%) [<math>\chi^2(1, n = 2035) = 38.7, p &lt; 0.01</math>].</li> <li>• Problem gambling scores significantly increased (<math>M = 0.131</math> vs <math>M = 0.198, t(1719) = 2.54, p &lt; 0.05</math>) in Niagara Falls, and were significantly lower in Ontario (<math>M = 0.140</math> vs <math>M = 0.198, t(2104) = -2.47, p &lt; 0.05</math>).</li> <li>• In Niagara Falls, prevalence of Short SOGS 2+ rose from 2.5% to 4.4%.</li> <li>• In Niagara Falls, prevalence of Short SOGS 3+ rose from 0.7% to 2.3%.</li> </ul>
Room et al. (1999)†	Niagara Falls, Ontario, Canada	<ul style="list-style-type: none"> <li>• Adult residents</li> <li>• Pre-casino opening: Niagara Falls: <math>n = 677</math></li> <li>• Post: Niagara Falls: <math>n = 1076</math> Ontario: <math>n = 1005</math></li> </ul>	<ul style="list-style-type: none"> <li>• t-test</li> </ul>	

Table 1  
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Authors	Jurisdiction	Sample	Analysis	Findings
Rush et al. (2007)†	Ontario, Canada	<ul style="list-style-type: none"> <li>Problem gambling treatment centre managers (<math>N = 45</math>)</li> <li>Casinos (<math>n = 13</math>)</li> <li>Racetracks with EGMs (<math>n = 15</math>)</li> </ul>	<ul style="list-style-type: none"> <li>Logistic regression</li> <li>Mapping</li> <li>Interpolation spatial cluster scan</li> </ul>	<ul style="list-style-type: none"> <li>Exposure to gambling venues had a modest, but significant, positive association with being a problem gambler. Statistics were not provided because of issues of disclosure with external bodies.</li> </ul>
Sevigny et al. (2008)†	Quebec, Canada	<p>Study 1: Residents living up to 981 km from Montreal casino (<math>n = 8842</math>)</p> <p>Study 2: Residents living within 100 km of Montreal casino (<math>n = 5,158</math>)</p>	<ul style="list-style-type: none"> <li>Cochran–Armitage test, Chi-square</li> <li>Jonckheere–Terpstra (J–T) tests</li> </ul>	<ul style="list-style-type: none"> <li>Negative significant association between casino proximity and gambling participation (in provincial Quebec and Montreal), <math>p &lt; .001</math>, and expenditure (where residence within a 100-km radius of a casino spend the most on average vs those 100–200 km and 300+ km), <math>p &lt; .0001</math>.</li> <li>No significant association with proximity was found with pathological or probable pathological gambling or income.</li> </ul>
Shaffer, H., & Hall, M. (2002)†	Unspecified, United States	<ul style="list-style-type: none"> <li>1176 full-time employees</li> <li>6 casino</li> </ul>	Descriptive statistics	<ul style="list-style-type: none"> <li>Level 1 problem gambling: T1: 77.2%; T2: 86.2%; T3: 85.2%</li> <li>Level 2 problem gambling: T1: 18.4%; T2: 11.8%; T3: 13.0%</li> <li>Level 3 problem gambling: T1: 4.4%; T2: 2.0%; T3: 1.8%</li> </ul>
Shaffer et al. (2004)†	Nevada, United States	Nevada county residents and gaming venues	Descriptive statistics	<ul style="list-style-type: none"> <li>There was a linear relationship between Regional Index of Gambling Exposure and problem gambling rates (0% vs 8.4% problem and pathological gambling).</li> <li>Counties and individuals with longer periods of exposure have lower problem gambling rates.</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
South Australian Centre for Economic Studies (2006)	Regional cities of South Australia, Australia	Gaming machine venues and machines	Econometric analysis	<ul style="list-style-type: none"> <li>• Following a loss of 175 (7.7%) machines, net revenue increased by 4.9% (metro: 0.2%; rural: 3.5%).</li> <li>• EGM reductions of approximately 10.4% in South Australia (Provincial Cities 11.5%) were required to achieve a 5.3% reduction in NGR (Provincial Cities: 3%).</li> </ul>
South Australian Centre for Economic Studies (2008)*	Tasmania, Australia	Representative sample of Tasmanian adults ( $N = 4051$ )	<ul style="list-style-type: none"> <li>• Descriptive statistics</li> <li>• Model fitting (2-stage least squares regression)</li> </ul>	<ul style="list-style-type: none"> <li>• Highest deciles of economic advantage spent 0.2%–0.5% of their income, vs 1.6% and 2.1% in lowest deciles.</li> <li>• EGM density was correlated with the number of venues licensed for EGMs, median incomes, the proportion of the population aged over 55, and the proportion of the population of adults employed in blue-collar occupations (<math>R^2 = 0.678, p &lt; 0.05</math>).</li> <li>• EGM density was positively correlated with expenditure per adult in a district (<math>t = 4.16, p &lt; .001</math>).</li> <li>• Travel-time to the nearest casino was not significantly correlated with the number of helpline callers (<math>p = 0.161</math>).</li> </ul>
Storer et al. (2009)†	Australia and New Zealand	32 Australian and New Zealand datasets from 1991 to 2007 ( $N = 184,455$ )	Multivariate linear regression	<ul style="list-style-type: none"> <li>• Each additional EGM introduced results in an increase of between 0.6 and 1.0 problem gamblers with an average of 0.8 problem gamblers per EGM.</li> <li>• An average annual decrease in prevalence of 0.09% is expected where there is no change in EGM density.</li> </ul>

Table 1  
Continued

Authors	Jurisdiction	Sample	Analysis	Findings
Thalheimer, R., & Ali, M. M. (2003)†	Illinois, Iowa, and Missouri, United States	<ul style="list-style-type: none"> <li>• 38 riverboats and racinos</li> <li>• 153 observations, 1991 to 1998</li> </ul>	Generalized least squares regression	<ul style="list-style-type: none"> <li>• Spend will increase the closer a venue is located to a dense population centre. The estimated model shows that a 10% increase in access from the sample average will increase wagering by 4%.</li> </ul>
Toneatto et al. (2003)†	Niagara Falls, Ontario, Canada	853 residential substance abusers	Cross-tabulations and ANOVA	<ul style="list-style-type: none"> <li>• Participation in EGMs doubled 2 years after the introduction of a casino (17.5% vs 31.8%).</li> <li>• The mean SOGS scores of respondents who gambled on EGMs weekly or more often more than tripled within 2 years after introduction of the casino (<math>M = 2.6</math> vs <math>M = 7.1</math>, <math>p &lt; .001</math>).</li> </ul>
Welte et al. (2007)†	United States	Representative adult residents ( $n = 2631$ )	Tobit regression	<ul style="list-style-type: none"> <li>• An increase of 0.09 units on the problem scale for each additional casino within 10 miles was observed for respondents aged 30 years or older.</li> <li>• Each unit of casino convenience was associated with an increase of 0.8 units on the problem gambling scale.</li> </ul>
Welte et al. (2004)†	United States	Adult residents ( $n = 2631$ )	Tobit regression	<ul style="list-style-type: none"> <li>• Neighbourhood disadvantage increased odds of being a pathological or problem gambler by 69%.</li> <li>• Problem or pathological gambling rate increased with proximity (<math>&lt; 10</math> miles: 7.2%; <math>&gt; 10</math> miles: 3.1%; OR: 1.9).</li> </ul>
Wheeler et al. (2006)†	New Zealand	Non-casino gaming machines	Geographically weighted regression	<ul style="list-style-type: none"> <li>• Gaming machines were disproportionately sited in the most deprived areas of New Zealand.</li> <li>• Least deprived: OR = 1.00; Most deprived: OR = 6.18 (CI: 3.05, 12.49), <math>p &lt; 0.001</math></li> </ul>

† Peer reviewed academic journal; \*Government report; †Book chapter; †Local government report; LGA=Local Government Area; CAD = Canadian Dollars; NCGM = non-casino gaming machines; NCGV = non-casino gaming venue; OR = odds ratio.

### Proximity of gaming venues and gambling involvement

Despite cultural, demographic, geographic, and regulatory differences across studies from different jurisdictions, the findings indicate a positive relationship between venue placement and impacts on the surrounding community's gambling involvement. A New Zealand study suggested that after accounting for socioeconomic and demographic factors, greater proximity (i.e., within 3 km) to NCGVs may increase the likelihood of gambling involvement by as much as 72% (95% CI: 1.32–2.24,  $p < .05$ ). However, this study had investigated three distance categories (< 734 m, 735–1316 m, and 1317–3076 m) and found no significant difference between the distance categories in their level of risk of increased involvement. Considering that the risk level is relatively similar when only proximity is taken into account, it may be that density of venues within these small regions would better discriminate levels of risk (Mason, 2008).

A longitudinal study comparing two Canadian cities, one with a casino (Gatineau, Quebec) and one without (Quebec City, Quebec), found more complex associations. Gatineau (formally Hull) residents reported significantly higher frequency of gambling than residents in the control city after controlling for income ( $F = 76.66$ ,  $p < .01$ ); however, the sharp increase in gambling in the first 12 months declined over the 4 years of the study. While expenditure increased in both regions over the four years, the maximum amount of money gambled in a day by Gatineau respondents was significantly higher than Quebec City residents at one-year and four-year follow-up ( $F = 14.95$ ,  $p < .01$ ). Interestingly, in both cities, the number of games played initially increased then significantly decreased to below the average played prior to the casino's opening. The authors suggested their findings provided support for the regional exposure model, where exposure increased involvement, and adaptation was also observed in the reduction in gambling participation in the years following the casino's opening. They suggested that research would benefit by investigating the behaviours of those at risk, rather than random population samples (Jacques & Ladouceur, 2006). Two studies that investigated this relationship with high-risk groups found that young adults who attended a university near a casino reported higher participation rates compared with their peers (55.3% vs 29.1%) (Adams et al., 2007) and that gaming venue staff similarly reported higher participation rates compared with state participation rates (95.9% vs 77.4%) (Hing & Nisbet, 2009).

Studies have also demonstrated that greater proximity to gaming venues is related to increased expenditure. People who travelled less than 3.45 km to their regular club reported spending more than three times the amount as patrons who travelled a greater distance to their regular club (AUD \$1856 vs AUD \$580) (Marshall, McMillen, Niemeyer & Doran, 2004).

All of the above studies have defined and measured proximity as the physical distance between a gaming venue or cluster of gaming venues and a point of origin (e.g., respondent's residence or a geographic centroid), without taking venue characteristics into account. In contrast, two Australian studies proposed social and psychological dimensions of proximity in relation to venue characteristics. Doran,

Marshall, and McMillen (2007) proposed that social and spatial factors affect the distances people will travel to a given venue. They found that more people would travel greater distances to venues that are in close proximity (< 0.5 km) to places of large social congregation (e.g., churches, schools, or shops) than to more commercially isolated venues. There was also some indication that willingness to travel greater distances was also associated with larger venues and venues with greater numbers of EGMs, but this association was less clear. It is likely that this finding has implications for the way that proximity, and accessibility more broadly, are operationalised. Often, proximity is measured according to the distance from a place of residence to a venue; however, the Doran et al. (2007) study suggests that a venue's proximity to a place regularly attended (e.g., a shopping centre) is an important dimension of physical accessibility, as also suggested by the Productivity Commission (2010). It is clear that this dimension would be important in jurisdictions with NCGVs, which are usually located near places of community congregation; however, it would be interesting to investigate whether the effects of venue proximity generalise to destination venues such as large casinos that also provide shopping, entertainment, and dining. The other study further expanded the concept of access by investigating perceptions of accessibility by venue workers. Hing and Nisbet (2009) investigated cognitive, social, and physical access to gaming venues and gambling involvement and problem gambling rates among venue workers. They developed a measure of the three factors, where the *cognitive access* scale comprised items regarding familiarity with and knowledge of how a gaming product works; *social access* comprised items regarding familial, peer, work, and personal approval of gambling; whilst *physical access* comprised items regarding the convenience of the venue's location, its choice of games, and availability in terms of queues to games and opening hours. They found that physical accessibility of EGMs did not significantly predict frequency, expenditure, or duration of EGM gambling among venue workers. As the authors suggested, a possible reason for this is that all study participants had easy physical access to EGMs. Those who rated EGMs as extremely socially accessible were more likely to have gambled on EGMs than those who rated it somewhat difficult; however, this was not reflected in increased expenditure or time spent gambling on EGMs. Eighty-three per cent of those who rated cognitive access to EGMs as "extremely easy" gambled on EGMs, compared to 49% who saw it as "somewhat difficult". These people gambled approximately twice as often on EGMs and spent almost four times as much money (\$A49.25 vs \$A13.86) and almost three times as much time per month (32 vs 12.7 minutes) on EGMs than people who rated cognitive access as "somewhat difficult". These findings suggest that, under the assumption of at least reasonable proximity to a venue, social and cognitive factors, such as those defined in this study, might have significant impacts on the level of gambling involvement an individual will engage in.

### **Proximity of gaming opportunities and problem gambling severity**

Several studies have investigated the association between proximity to gaming venues and problem gambling severity. Three such studies meeting criteria for

inclusion in the review investigated this association with community samples. Overall, the findings support exposure theory, demonstrating increasing risk of problem gambling severity with greater proximity to gaming venues. Further, there was also support of adaptation theory, suggesting that this association diminishes somewhat over a number of years.

An archival analysis of national health surveys and census data in New Zealand (Mason, 2008) found that residents living within 700 m of an NCGV were 60% more likely to be problem gamblers who had gambled in a venue in the last year than those living farther away after controlling for demographic factors. Residents living within 700 m of a NCGV were 84% more likely to be problem gamblers than those who had travelled more than 3 km after controlling for demographic factors. This relationship was stronger when metropolitan area, level of deprivation, and socioeconomic factors were also accounted for (OR 2.71, 95% CI: 1.45–5.07,  $p < .05$ ). Comparison of these findings should be made with caution, however, because the authors developed a list of items related to indicators of problem gambling rather than using a standardised problem gambling screen. The rationale for doing so was not discussed in the report.

While Gerstein et al. (1999) found that problem gambling rates within a 50-mile radius of a casino were double those at 50–250 miles from a nationally representative US sample of 100 communities, a study of Montreal and provincial Quebec residents found no significant association between proximity to a casino and problem gambling rates in either region. While not statistically significant, those districts farthest from a casino in provincial Quebec had a higher proportion of residents who earned less than CAD\$40,000 and approximately three times the rate of problem gambling than the district closest to a casino. Unfortunately, any interaction effect was not examined. In Montreal, while again not significant, a similar pattern was observed. The district farthest from a casino had higher rates of expenditure, had more residents who earned less than CAD\$40,000, and had twice the problem gambling rate of closer districts (Sevigny, Ladouceur, Jacques, & Cantinotti, 2008). These findings suggest that in provincial Quebec and Montreal, income may be a more significant risk factor for problem gambling than proximity to a casino, possibly suggesting that less affluent people will travel some distance if they are attracted to casino gambling. An important limitation, however, is that proximity to other gambling opportunities, such as lottery and sports and race betting outlets, was not considered. This is a limitation of most included studies, as few have taken into account the accessibility of multiple forms of gambling.

Hing and Nisbet (2009) reported a higher prevalence of problem gambling among gaming venue staff than in the Victorian adult population (5.6% were problem gamblers and 13.7% were moderate-risk gamblers vs 0.97 and 0.91, respectively, in Victoria). They acknowledged that these employees might have been drawn to the industry by their interest in gambling; however, they also suggested that their findings supported exposure theory because staff gambling involvement increased

after employment, and staff that regularly assisted customers with gambling machines, promotions, and cashier duties were found to be more vulnerable. Shaffer and Hall (2002) surveyed recently employed US casino staff over a period of three years. At baseline, soon after their appointment, approximately twice as many staff members were classified as problem gamblers using the South Oaks Gambling Screen (SOGS) (4%) as community samples (R. A. Desai, M. M. Desai, & Potenza, 2007); however, prevalence rates halved by the third year to 2%, indicating adaptation to exposure within a three-year period for many employees. The authors noted that employees had participated in a general health program at the beginning of the study period, although they suggested that this may not have had a significant effect on gambling behaviour since it was not specifically about gambling. Nevertheless, future studies investigating gambling participation by venue staff would benefit by including comparison venues to control for confounding variables such as staff training.

Taken together, these studies suggest that greater proximity to gaming is associated with an increase in the risk of problem gambling; however, this association appears complex. Other factors that may be associated with risk of problem gambling include other gambling opportunities, sociodemographic risk factors, and adaptation to gaming opportunities over time leading to decreased interest. The processes related to adaptation have not been directly examined. Future studies could further examine the role of accessibility and adaptation in gambling involvement and problem gambling among vulnerable groups such as venue workers, young people, and people with a history of mental health conditions (Lorains, Cowlshaw, & Thomas, 2011; Shaffer & Hall, 2001).

It should be noted, also, that a number of studies have investigated proximity to multiple small venues with gaming machines, while others have investigated proximity to a casino or a large club-style venue (destination gaming venues), making comparisons between studies problematic. Given the findings reviewed within the parameters of this systematic review, an association between proximity and problem gambling is complex. This may be a consequence of significant differences in methods and design, although it is generally consistent with findings of research in alcohol venue proximity (Kavanagh et al., 2011; Popova, Giesbrecht, Bekmuradov, & Patra, 2009).

Further, studies that have investigated proximity have relied on the assumption that the community is not more broadly mobile. Proximity has been measured in terms of the distance from one's home to a venue. These studies neglected to account for the travel time from other locations regularly attended, such as work, dining or drinking establishments, and shopping centres. This issue also relates to the subjective perception of distance, which requires further investigation. While there is a degree of empirical rigour in objective measurements (i.e., metres, miles, minutes ascertained from geographical data), it is possible that the subjective perception of distance is a more accurate measurement of physical accessibility. For example, two

people may be equally likely to gamble even though one might live 30 km farther away from a venue because they are accustomed to travelling 30 km or more to most locations and are just as likely to make the trip as the other person.

Hing and Nisbet (2009) noted that physical accessibility may not have been a significant predictor of problem gambling among venue workers because they all have equal, easy access through their work and easy access to other venues on their trip home from work. This may be a confounding variable in studies of other regions where many NCGVs are available in residential areas and areas of community congregation, so that proximity would not discriminate between problem and at-risk gamblers in these regions. Proximity to a venue would arguably be more relevant to research in cities where only destination gaming (e.g., casinos and racinos) was available. There is some evidence that the primary characteristic of a venue that draws patrons is how convenient it is to travel to it (Shoemaker & Zemke, 2005). It could be argued that regular gamblers would choose to live in close proximity to a gaming venue, although the evidence suggests that this is not likely to be a significant confounding factor for a number of reasons. The location of gaming venues is carefully planned through market analysis to ensure placement in environments that will yield optimal profits based on demographics and competing industry (Fung & Wilkes, 1998), or based on the cluster economy model (Pascal & Stewart, 2009), where co-dependence with other industry can raise the profile and traffic of both industries. For example, the gambling industry in the United States has observed that the development of “casino-outlet centres” is a “sure thing” to greatly increase revenue for both industries because similar demographic groups are attracted to both retail shopping and casino gaming (Maunder, 2011, p. 8).

### **Location of gaming venues and SES**

It has been proposed that venues are located in areas of low SES and that SES is a moderator of the association between physical accessibility and problem gambling (Productivity Commission, 2010). While SES has been shown to be related to problem gambling (Productivity Commission, 2010; Welte et al., 2004), there is as yet limited evidence of its interaction with proximity to gambling venues and problem gambling (Doran & Young, 2010; Marshall et al., 2004). Some evidence suggests that non-casino gaming venues tend to be located in lower socioeconomic areas (Marshall & Baker, 2002; Pearce et al., 2008; Wheeler, Rigby, & Huriwai, 2006) and that individuals in these areas spend more on EGMs per adult (Delfabbro, 2002; Diamond, 2009) and as a proportion of their income (SA Centre for Economic Studies [SACES], 2008) across metropolitan and regional areas (Doughney, 2002). Further, this association may be stronger among those who gamble in NCGVs as opposed to other venues (e.g., TABs where one can place bets on horse or dog races) (Pearce et al., 2008). Evidence suggests that individuals living in areas of greater disadvantage are at significantly greater risk of problem gambling than those with similar physical access to NCGVs but who are living in areas of higher socioeconomic advantage (Delfabbro, 2002). In New Zealand, it was

reported that as many as 80% of problem gamblers who had gambled in NCGVs in the past 12 months lived in regions of greatest economic and social disadvantage (Pearce et al., 2008). In the United States, living in an area of neighbourhood disadvantage increased one's chances of being a problem gambler by 68% (Welte et al., 2004). Just one included study reported conflicting results, where proximity to a casino was positively correlated with an income of over CAD\$40,000 per annum in regional Quebec, but with less than CAD\$40,000 per annum in Montreal (Sevigny et al., 2008). While different measures of disadvantage or SES are used by each study, it appears that there is a relationship between SES and physical accessibility, and gambling involvement and problem gambling. However, the mediating or moderating effect of SES in the relationship between accessibility and gambling involvement and problem gambling has yet to be clearly ascertained. SES is a factor that should be accounted for in models of accessibility and gambling.

### **The influence of the density of gaming opportunities on gambling behaviour and problem gambling**

Australia and New Zealand have a high density of EGMs in residential areas compared to comparable countries such as the United States (Young, 2010). This density of venues and gaming machines has intensified concerns about problem gambling in the community. Density of gaming venues in suburban areas appears to be associated with risk of increased gambling involvement, with evidence of increased expenditure, including in areas with high economic disadvantage. Australia has a relatively high density of gaming venues and machines for its population in most cities and many regional centres (approximately 10 machines per 1000 adults) (Delfabbro, 2008). This environment permits an excellent opportunity to examine relationships between density and gambling involvement. Australian studies have reported that the density of EGMs in a small region (local government area) within a city was strongly correlated with annual net revenue per adult (Adelaide:  $r = 0.92$ ,  $p < 0.001$  [Delfabbro, 2002]; Tasmania:  $t = 4.16$ ,  $p < .001$  [SACES, 2008]). High-density regions had the highest participation rates over the previous six months ( $R^2 = 0.71$ ,  $p < .05$ ) and previous week ( $R^2 = 0.73$ ,  $p < .05$ ) (Marshall, 2005) and average spend was higher (Productivity Commission, 2010). For example, in Tasmania, the highest-density region reported spending \$294 per adult, per annum (i.e., 20%) more than the lowest-density region. Compounding the effects of expenditure, these regions tend to be more disadvantaged regions or rate more highly in indicators of social disadvantage such as high unemployment, lower median incomes, low rates of higher education, a high proportion of single parents and people over the age of 55 (Delfabbro, 2002; Diamond, 2009; Gilliland & Ross, 2005; Mason, 2006; SACES, 2008).

In Adelaide, density better predicted spend on machines than age (20–39 years), government housing trust residence, Aboriginal or Torres-Strait Islander origin, or separated or divorced and never married statuses (Adj.  $R^2 = 0.55$ ;  $F(6, 44) = 26.44$ ,  $p < .001$ ) (Delfabbro, 2002).

In New Zealand, a large-scale national study reported that residents in regions with a high density of NCGVs were significantly more likely to gamble on EGMs (OR = 1.67, 95% CI: 1.25–2.23,  $p < .05$ ) but problem gamblers from these regions were not significantly more likely to gamble (Mason, 2008).

These findings are similar to Australian research on alcohol consumption and density of outlets, which have reported a strong positive linear relationship between density and consumption (Kavanagh et al., 2011; Livingston, 2008; Popova et al., 2009).

While there is considerable evidence of an association between greater gambling involvement and density (Productivity Commission, 2010; Wardle et al., 2011), a limitation of these studies is that they did not also directly investigate associations between density and problem gambling, with the exception of one New Zealand study, which found no association (Pearce et al., 2008).

A noteworthy exception to the above findings is a study conducted of three local government areas (LGAs) in Melbourne, Australia (McMillen & Doran, 2006). It found that expenditure was not significantly higher in parts of the LGA that had a high density of NCGVs than in other parts with lower density of venues. This indicates the importance of methodological design. This study was unique in examining density and expenditure within an LGA, rather than across LGAs. As the authors suggested, other factors of accessibility, such as a venue's proximity to centres of congregation (e.g., shopping centres) and venue opening hours and size might confound relationships between density, and patronage and expenditure. This confounding effect might be more pronounced when comparing small neighbouring regions (e.g., within an LGA) to larger regions with and without high density (e.g., across LGAs).

The experience in South Australia and Victoria following the removal of thousands of EGMs is also relevant to measurement parameters of density in future research. Evaluations of the reduction of machines (not venues) found no change (or in cases even an increase) in expenditure across the state or per machine. While the density of machines dropped, the venue density did not. In addition, it was suggested that most machines that were removed were those that were less popular and profitable, in effect making the venues more efficient (Delfabbro, 2008; O'Neil et al., 2005). This again highlights the importance of assessing other aspects of accessibility, such as venue characteristics; however, it also suggests a minimum difference in density between regions in order to elicit significant behaviour change. The evidence to date suggests that a greater density of gaming opportunities is associated with increased involvement, which is associated with increased gambling problems (SACES, 2006).

A meta-analysis of Australian and New Zealand prevalence studies found that for each additional EGM in an area, there would be an additional 0.8 problem gamblers

per EGM. The authors concluded that there was no evidence of a ceiling effect with increasing EGM density (Storer, Abbott, & Stubbs, 2009). This seems unlikely considering usual consumer patterns where market saturation limits consumption; however, increasing population density might also be a factor in the model. The above studies of the removal of EGMs add weight to the theory of a ceiling effect where further increase of machines will not substantially increase expenditure (or reduction of machines to a point above the ceiling will have little impact on expenditure). A challenge for researchers is to tease out behavioural impacts of saturation and adaptation, if they do in fact influence behaviour. The point at which a region reaches this ceiling requires investigation for the development of public health policy interventions, but also for research purposes, such as defining “low density” and “high density” of gaming machines and venues.

### **The introduction of new gaming opportunities and their effects over time**

The opening of the Niagara Falls casino in 1996 provided an opportunity to analyse the effects of introducing a large gaming venue into a previously casino-free community. Two studies conducted prospective investigations of the health, social, and economic impacts of the casino on the Niagara Falls and Ontario communities (Room et al., 1999; Toneatto, Ferguson, & Brennan, 2003). Room et al. (1999) compared Niagara Falls community and Ontario provincial baseline data with gambling behaviours one year later. Participation rates significantly increased the first year in Niagara Falls and to a lesser extent in Ontario [ $X^2(1, n = 1753) = 191.7, p < .01$ , and  $X^2(1, n = 2035) = 38.7, p < .01$ , respectively]. Average scores on SOGS short version and the number of residents who reported being criticised by family or friends and knowing someone with a gambling problem significantly increased at follow-up among Niagara Falls residents and were significantly higher than the figures reported of Ontario residents at follow-up. Toneatto et al. (2003) compared gambling behaviours and problem gambling of alcohol and drug abuse treatment-seekers in Niagara Falls in 1996 (the year the casino became operational), 1997, and 1998. They found that casino and EGM gambling significantly increased among this vulnerable group. Problem gambling prevalence rates doubled within the first year, and the rate was sustained for two years. Symptoms also became more severe, with mean SOGS scores tripling among treatment-seekers from 1996 to 1998 ( $M = 2.6$  vs  $M = 7.1, p < .001$ ). This study brings to attention the importance of investigating the effects of accessibility on vulnerable groups, in addition to large-scale effects on general populations where effects may become more diffuse.

In contrast, a 4-year prospective study of the introduction of a casino in Hull (Gatineau, Quebec) found a significant increase of problem gambling 12 months after the casino’s opening but no significant difference in incidence of problem gambling among Hull or Quebec provincial residents from before the casino opening to 4-year follow-up (Jacques & Ladouceur, 2006). This initial spike, then plateau or decline over a period of three years, may be evidence of the adaptation

theory proposed by LaPlante and Shaffer (2007). Few longitudinal studies have been conducted, and any suggestions of adaptation must be made with great caution. More prospective long-term studies are required to better understand the factors involved in this process (assuming adaptation does in fact occur with reliability). This could contribute to the development of more sensitive, gold-standard methodological designs and instruments to examine influential and confounding factors, enhancing rigour and consistency of methodology.

Research into the effects of the introduction of gaming venues from Australia is lacking, and no prospective studies have been conducted. The data available present a different picture to that from Canada, possibly because as well as casinos, most major cities have installed EGMs in many existing venues (e.g., pubs and sports clubs) in suburban areas (e.g., suburban commercial districts). The findings of those studies suggest that the adaptation effect may be moderated by greater NCGV density in a neighbourhood. In Adelaide, the increase in EGM numbers from 1996 to 2002 was strongly positively correlated with increased net revenue per adult ( $r = 0.78$ ,  $p < .001$ ) (Delfabbro, 2002). Seven years after their introduction in Victoria, greater EGM numbers were strongly positively correlated with greater spend regionally ( $r = 0.82$ ). Potentially compounding financial stress, within two years of their introduction in Victoria, EGMs were increasingly placed in lower SES LGAs ( $R^2 = 0.23$ ). This relationship strengthened over the following four years ( $R^2 = 0.60$ ) (Marshall & Baker, 2002).

Conversely, an interesting case study of the removal and banning of EGM gambling in Norway in 2007 has been reported (Lund, 2009). Participants were surveyed 2.5 months before removal and again four months after the ban. On average, respondents reported a decrease in overall gambling participation and gambling problems. Participation across all gambling forms in total fell from 98% to 78.2% of the population, with the exception of bingo automats and for regular EGM gamblers and problem gamblers. Moreover, the proportion of people who reported that they had lied about their gambling and felt they had needed to bet more fell from 1% to 0.4% ( $p < .05$ ) in the four months following the ban. Significantly lower rates of chasing losses were also reported (3.5% vs 1.9%,  $p < .05$ ).

### **Reduction of gaming machine numbers and hours of access**

In response to evidence of negative health, social, and economic impacts of the proliferation of EGMs in residential areas, both the Victorian and South Australian governments introduced regional “caps” policies limiting the density of EGMs in socially disadvantaged areas. The effectiveness of this supply-targeted harm reduction initiative was evaluated in three studies (Delfabbro, 2008; Marshall & Baker, 2002; O’Neil et al., 2005; SACES, 2006). Overall, the evaluations did not report a statistically significant reduction in gaming participation, spending, or harms in the local area or state jurisdiction they investigated. In fact, a significant increase in gaming machine revenue was observed in South Australia (Delfabbro,

2008), and a decline in revenue in the LGAs investigated in Victoria was consistent with a general decline over the same time period, across the state (O'Neil et al., 2005). Analysis of net gaming revenue over a three-year period in regional cities and Adelaide indicated that a proportionally similar removal of machines had a smaller impact on spending in regional areas (5.3% vs 3% reduction in spend). EGMs were still easily accessible to most gamblers, and only 2% of those who reported any difficulty accessing EGMs reported that this reduction in EGM numbers helped them to control their gambling; however, these respondents did report reduced urge to gamble and that they were in control of their gambling (SACES, 2006). The only significant negative effect on revenue by restrictions was observed in Victorian venues, where a 3.3% decline in revenue was reported by venues that were no longer permitted to open for 24 hours. A small decline in help-seeking was observed across Victoria in the three years following the removal of machines (O'Neil et al., 2005). The South Australia Centre for Economic Studies (2006) concluded that "[r]educing machine numbers is not particularly effective in reducing expenditure nor in addressing the behaviour of problem gamblers" (p. ii). McMillen and Doran (2006) suggested that the cap system used in Victoria was too simplistic and did not address other important factors, including the types and combination of EGMs in a venue, technological innovation, the proximity of venues to community facilities, consumer preferences, venue marketing strategies, convenient travel routes and parking facilities, localised pockets of affluence and disadvantage, changing urban and economic conditions, and other policy impacts. These involve spatial, temporal, and attitudinal aspects of accessibility that should not continue to be neglected in future research.

In contrast, Nova Scotia removed approximately 30% of their video lottery terminals (VLTs) and observed a substantial reduction in expenditure 12 months later (Corporate Research Associates Inc., 2006). Twelve percent of VLT gamblers reported that they had reduced their spending due to this measure by an average of CAD\$67. The group to have been the most impacted was problem gamblers, with 57% reporting that they had decreased their spending, the average for this group being CAD\$146, the largest amount of money of all problem gambling severity groups. This group also reported gambling for an average of 200 minutes less each week. This might not be surprising, however, as it would be expected that they would be spending the most money and time and therefore could moderate their behaviour by a greater amount. The study did address the possibility that VLT gamblers who reported moderating their gambling had simply redirected their gambling to another venue or mode (e.g., horse racing or poker) and found that only 8% had started gambling at other VLT venues, and only 3% had changed to other gambling activities (Corporate Research Associates Inc., 2006). No analysis of statistical significance was conducted, nor was there report of the proportion of VLT gamblers who increased their involvement or did not change. The contrast between the Australian and Canadian experiences may be explained by the comparatively small proportion of machines that were removed in South Australia (approx. 14.5%) and in Victoria (approx. 5%).

## Discussion

This systematic review of peer-reviewed and grey literature has revealed that the relationships between the physical accessibility dimensions of proximity and density and gambling involvement and problem gambling are complex. Research is only beginning to elucidate these dimensions, and many questions and methodological challenges remain to be addressed.

The synthesis of the included literature indicates a positive relationship between proximity to gaming venues and gaming participation and increased expenditure on gambling and increased risk of problem gambling severity. Although high EGM density (EGMs per head of population) within a region appears to be associated with higher gambling participation and expenditure (i.e., gambling involvement) and other risk indicators, there are limited findings on any association with problem gambling rates. Moreover, there appear to be further important distinctions and complexities arising from investigating accessibility. First, evidence suggests where only destination gaming is available, both proximity and density are associated with higher rates of gambling involvement and problem gambling. However, where gambling opportunity is diffuse, both proximity and density are associated with greater involvement, but proximity, rather than density, might be more strongly associated with higher rates of problem gambling. Second, gambling involvement appears related to the gambling market, where diffuse gaming venue environments are more strongly related to gambling involvement and problem gambling than when only destination gaming is available. Third, gambling involvement appears to be a function of the maturity of the market, where communities in general appear to adapt to the introduction of gambling opportunity while problem gamblers appear to increase their gambling as their exposure increases. Fourth, gambling appears to be associated with sociodemographic factors, specifically lower SES.

Finally, the review aimed to critically examine the literature and provide recommendations for future research directions. Within the literature sourced for this review, there was great diversity of conceptual and operational definitions, assumptions, types of data, data collection methods, instrumentation, and analysis. For example, samples have varied from household telephone survey data to governmental archival data to mixed data collection methods. Congruent with the diversity of objectives, samples, and methods, the analyses have varied from geographic information system (GIS) spatial analyses to econometric analyses to regressions and t-tests. However, overall, this is not a limitation of the literature, but instead indicative of the complexity of the issue; the diversity of social, political, and industry environments; and the broad scope of study objectives. Indeed, overall, the studies have applied an approach that was acceptable for their objectives and the social and gaming market model for their jurisdiction. In light of this, this review has critiqued individual studies, but has focused on highlighting the strengths and gaps in the body of research as a whole, and provided recommendations for future

research directions. The discussion and recommendations for future research are presented according to the relevant aspect of research design.

### **Concept of accessibility**

It appears relatively accepted that accessibility is a multidimensional construct; however, few researchers have attempted to explicitly theoretically explore or define accessibility or its dimensions. Consequently, accessibility remains a relatively loose term, implicit and inconsistently examined. The literature has predominantly addressed the physical accessibility dimensions of distance and density. While these dimensions appear to be important to our understanding of environmental risk factors and to development of efficacious harm minimisation strategies, the additional dimensions of accessibility as described by Hing and Haw (2009), Hing and Nisbet (2009, 2010), and the Productivity Commission (2010) indicate possibilities of expanding the definition of accessibility and the focus of future accessibility research.

The use of different operationalisations of definitions complicates comparisons across the studies, and caution is required when generalizing the findings beyond the jurisdiction investigated. For example, in Australia, density has been defined as the number of EGMs per 1000 persons in a local government area (Delfabbro, 2002; Marshall & Baker, 2002; SACES, 2008) and in New Zealand as the number of EGMs within 5 km of a neighbourhood centre (0–21, 22–177, 178–447, and 448 or more machines) (Mason, 2008). However, as discussed above, rather than these inconsistencies being a significant limitation of the field, they should be recognised as a function of the multi-dimensionality of the construct being examined and the influence of the gaming market model on the socioecological and political environments of the jurisdictions under examination. Future studies should take care to define these jurisdictional characteristics clearly and make comparisons with, and recommendations for, other jurisdictions that are matched in these characteristics.

### **Underlying model**

Few studies have applied a theoretical framework, and some have failed to articulate their assumptions. There is some evidence that the regional exposure and adaptation theories may provide an adequate model to examine risk factors over time and inform harm minimisation strategies aimed at supply regulation. However, empirical examination of this model requires investment in longitudinal studies and has some limitations; for example, it provides little opportunity to examine protective factors that could be promoted to enhance community resilience.

### **Measurement**

A significant concern regarding studies using archival data is the accuracy of the data collected. For example, one study used a short-form five-item version of the

SOGS, which has been subjected to little psychometric evaluation. Other studies incorrectly and inconsistently administered the Problem Gambling Severity Index in population studies to indicate problem gambling, most likely leading to underestimation of the prevalence rate, or combined respondents who were classified as moderate-risk or problem gamblers, presumably because there were too few problem gamblers in the sample to meet the requirements of the analyses they wished to conduct. Without correct problem gambling rates (and possibly other data), the findings and conclusions of studies reliant on these data are questionable. Conclusions made by such studies regarding adaptation are especially problematic because these modified administration and scoring methods typically underestimate problem gambling rates, which could be incorrectly interpreted as adaptation when they may be better attributed to the modified methods.

### **Samples**

Sampling has varied greatly, from surveys of residents of a state to gambling industry archival data that can be analysed across or within local government areas.

Research examining self-reports is useful for obtaining detailed information about behaviour and attitudes; however, this approach suffers from objectivity problems, such as memory bias. Research on online poker players has suggested that bias in reporting of gambling involvement could be moderated with the use of technology, such as user profiles, to provide more accurate data of individuals' gambling involvement during each gambling session (Griffiths & Whitty, 2010). The land-based equivalent may be available from loyalty card accounts, the data from which is routinely collected by the venue owner in many jurisdictions.

Use of archival data avoids the biases of self-report and can deliver a large dataset of detailed information for complex multivariate analyses. However, the rigour of administration and data collection of the original sources of the archival data may have been poor. For example, some studies have relied on problem gambling rates that had been estimated with modified measures that had undergone little or no psychometric examination. Another advantage of this design allows for analysis at the socioecological level, although few studies have also accounted for the effects of other gambling opportunities, such as agencies that provide off-track betting services, lottery or scratchcard sales, or bingo halls, on involvement or problem gambling. Finally, the sampling and analysis of these studies have been based on the assumption that venue accessibility from one's home is the only, or primary, measure of relevance. Studies have largely neglected to examine associations between gambling involvement and problem gambling and proximity to venues or venue density around the workplace and regularly visited commercial or social places such as shopping centres, schools, clubs, and licensed venues.

Some studies have attempted to employ a "natural" quasi-experimental study design by sampling from jurisdictions that are similar in many respects except for their

gaming market (e.g., the presence or absence of a casino or the density of gaming machines). Such a design is complicated by the many factors that should be considered to match jurisdictions as closely as possible, such as sociodemographics of the population, gaming machine density, the accessibility of other gambling opportunities, and the level of urban development in the jurisdictions. In addition, without careful articulation and examination of such factors, extrapolation of findings across jurisdictions is complicated by differences in ecological characteristics.

Finally, the review included studies that explored accessibility and electronic gaming among young adults and gaming venue workers. These studies provided further insight into the concept of accessibility and highlighted those associations that might not be statistically apparent at the gross community level. To support these distinctions, future studies could examine accessibility and potential mediating and moderating factors among segments of the population at increased risk of problem gambling, for example young people, shift-workers, and the disabled.

### **Environment and EGM saturation**

The introduction, proliferation, and removal of gaming venues and machines offer an opportunity to examine prospectively environmental factors and the validity of exposure and adaptation theory.

One approach to this is to examine whether the introduction or expansion of gaming opportunities is associated with an increase in problem gambling incidence (i.e., evidence of exposure), and whether this increase in incidence is moderated by time (i.e., evidence of adaptation). A prospective design would provide the opportunity to examine gambling involvement trajectories such as these. In addition, a longitudinal study design should account for potentially confounding factors such as venue proximity to commercial precincts (e.g., shopping centres), associated commercial outlets such as alcohol outlets, other gambling outlets (e.g., lottery, sports, or racing betting outlets), business or industrial districts (i.e., workplaces), the migration of gamblers and problem gamblers from other gambling activities to gaming machines, and SES.

Another approach is to examine the effects of the removal of machines and/or venues over time. Although there appears to be an association between the availability of gaming opportunity and increased gaming involvement and problem gambling, a number of studies of marginal interventions targeting this relationship, such as regional caps, have shown little or no reduction in gaming participation, spending, or harm. An obvious conclusion regarding a limitation of those interventions is that the reductions in machines were not large enough to elicit significant behavioural change. Indeed, the required reduction may have actually promoted greater machine efficiency, counteracting the desired harm reduction outcomes. Indeed, the study that investigated the largest reduction of machines

found a significant reduction in involvement across all problem gambling severity groups (Corporate Research Associates Inc., 2006). However, Hing and Nisbet (2010) argued that the number or proximity of machines or venues might not be ultimately important, as long as there is one machine that an individual can access. Without longitudinal evidence of a critical level of density that could guide such interventions, their implementation and regulation may be politically, rather than evidence, driven. However, longitudinal studies are expensive and require a committed team of researchers for an extended period of time. These requirements may be reasons why these studies are comparatively rare and the research questions that can be answered by this method have been rarely attempted.

### **Limitations of the review**

A limitation of this review is that the literature search was limited to English-language publications; a wider search of websites and bibliographies may have yielded a larger number of studies, especially from a greater diversity of countries. The review was also limited to studies where indicators of gambling involvement or problem gambling rates were the outcome variables. Studies that investigated associations between accessibility and social and economic costs of problem gambling outcomes, such as family breakdown, bankruptcy, and crime, could be examined in future reviews.

Moreover, this analysis compared studies from different locations in different countries with often quite different levels of dispersal of gambling opportunities at different densities operating under different government regulations. These issues further underline the need for accessibility to be investigated at the appropriate level of analysis for individual populations, and measuring several indices for comparisons with other studies to be meaningful; specifically, the current analysis suggests dispersal of gambling opportunity, market maturity, market type, and socioeconomic factors, particularly SES and urbanity.

### **Conclusion**

The systematic review revealed that while there appears to be a relationship between both proximity and density and increased gambling involvement, proximity may be more strongly associated with increased problem gambling rates than density of venues or machines. However, synthesis and extrapolation of findings are complicated by the diversity of gaming markets and are clouded by theoretical and methodological limitations. Accessibility as a multi-dimensional construct has been broached, but more work is required to conceptually define and operationalise its dimensions. Studies have not examined the impacts of the social and commercial context of venues (e.g., the venue's proximity to schools, shopping precincts, or licensed venues), and only some have accounted for sociodemographic factors such as SES. Another significant gap in the literature is the lack of prospective studies conducted. Prospective studies can effectively address many gaps in the knowledge,

including the role of exposure and adaptation, the impacts of a dynamic gaming market (e.g., the introduction or removal of gaming venues), the maturation of the market, and the impacts of public health interventions (e.g., change to venue opening hours). Finally, little research has been conducted with vulnerable groups, such as young people and shift-workers. The review was limited in scope as it included only reports published in English that investigated gambling involvement or problem gambling as the outcome variable. However, it represents the first systematic review of empirical studies of the relationship between accessibility to gaming opportunities and gaming involvement or problem gambling.

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