



Review Article

Impact of legislation on youth indoor tanning behaviour: A systematic review



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ARTICLE INFO

Keywords:

Indoor tanning
Legislation
Youth health
Health policy
Skin cancer
Cancer prevention

ABSTRACT

Jurisdictions around the world have implemented indoor tanning legislations, which aim to protect all individuals, especially youth, from dangers of artificial ultraviolet radiation exposure. The objective of this study was to conduct a systematic review to synthesize the available peer-reviewed literature to determine whether indoor tanning legislation has impacted the prevalence of youth indoor tanning. Following PRISMA guidelines, six databases were searched in 2016. Reference lists from relevant articles were also searched. An updated literature search was conducted in 2018. Each article was critically appraised using a merged checklist created from two previously validated checklists. All articles meeting the inclusion criteria were retained after appraisal. Seven studies, all conducted in the U.S., met the inclusion criteria. All studies used an observational, cross-sectional design. There were small absolute decreases in youth indoor tanning prevalence after legislation vs before ($n = 3$, mean = 3% decrease, range = 1%–6% decrease). Prevalence of youth indoor tanning was significantly lower in states with indoor tanning legislation vs states without legislation ($n = 4$, mean = 5% lower, range = 1%–18% lower). Prevalence of youth indoor tanning was lower in states with longer standing indoor tanning legislation vs states with more recently implemented legislation ($n = 2$, mean = 9% lower, range = 2%–20% lower). Indoor tanning legislation is generally associated with lower indoor tanning prevalence among youth. The small percent differences equate to millions of youth at the population level. Longer time lapses from legislation implementation to evaluation, coupled with greater enforcement, compliance, legislative stringency, and public education may result in even more pronounced declines in youth indoor tanning prevalence.

1. Introduction

Indoor tanning is a health risk behaviour requiring legislative efforts to curb its use and prevent disease. Artificial UV exposure can have many negative health impacts, especially for skin (Canadian Cancer Society, 2017). Exposure to artificial UV radiation causes DNA damage and mutation of skin cells, which can ultimately result in skin cancer (El Ghissassi et al., 2009).

Despite the health risks, the popularity of indoor tanning remains high, especially among youth and young adults (Nadalin et al., 2016). In 2013, an estimated 11.3 million Americans used indoor tanning devices, with 1.6 million of them under the age of 18 (Guy et al., 2016). Results from the 2017 American Youth Risk Behaviour Survey indicate that 5.6% of high school students used an indoor tanning device at least once over the previous year (Kann et al., 2018). Additionally, in 2014, an international systematic review of 16 countries found approximately

18% of adolescents had been exposed to indoor tanning in the past year (Wehner et al., 2014). Indoor tanning before the age of 35 increases the lifetime risk of melanoma by 59% (Boniol et al., 2012). Together, this points to adolescence as a critical period for UV exposure (Wehner et al., 2012). In response, a growing number of governments have implemented legislation to reduce indoor tanning access and use (Pawlak et al., 2012). Most of these legislations are focused on banning youth, as recommended by the WHO (The World Health Organization, 2003). In 2011, 11 countries had legislation banning youth under the age of 18 from indoor tanning (Pawlak et al., 2012). Specifically, in the U.S., 44 states and the District of Columbia have legislation restricting youth indoor tanning (National Conference of State Legislatures, 2018).

While numerous jurisdictions have indoor tanning legislation restricting youth access, the results of studies on the impact of this legislation have not been systematically compiled. To address this research gap, we conducted a systematic review to synthesize the available peer-

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<https://doi.org/10.1016/j.ypmed.2019.03.041>

Received 22 November 2018; Received in revised form 21 March 2019; Accepted 28 March 2019

Available online 30 March 2019

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reviewed literature to determine whether indoor tanning legislation has impacted the prevalence and frequency of youth indoor tanning and to characterize any such changes.

2. Materials and methods

2.1. Search strategy

Following PRISMA guidelines (Moher et al., 2010), six databases were systematically searched in November 2016 to obtain peer-reviewed literature concerning the impact of indoor tanning legislation on youth tanning. Search terms, published elsewhere (Reimann et al., 2018), were used in the following databases to yield articles: PubMed ($n = 6447$), Medline ($n = 5241$), JSTOR ($n = 133$), ABI/INFORM ($n = 149$), Business Source Complete ($n = 197$), and PsycINFO ($n = 230$). In total, 12,398 articles were located; 5492 were duplicates, leaving 6906 unique articles to be screened. Reference lists from relevant articles were searched, uncovering three additional articles. We returned to the literature in June 2018 to update the search, which uncovered one new article for screening. Web of Science and Google Scholar were used to search for new studies citing those already included in the review.

2.2. Selection criteria and data extraction

Articles had to meet the following inclusion criteria: peer-reviewed, written in English, focused on the impact of indoor tanning legislation regulating the commercial indoor tanning industry, focused on indoor tanning use by youth, and had a comparison group. Exclusion criteria included: systematic reviews or commentary style articles, grey literature, studies about spray/lotion/solar tanning, and studies about awareness of existing indoor tanning legislation. Using the inclusion and exclusion criteria, 6836 articles were excluded based on title and abstract screening. Full text screening excluded 64 articles, resulting in seven included articles. Fig. 1 details the course of article omission. Information was extracted from each article and is summarized in Table 1.

2.3. Critical appraisal

Each article was critically appraised using a merged checklist (Bracken, 1989; Downs and Black, 1998), which has been used previously (Reimann et al., 2018). Each critical appraisal item was given a score of up to 1, where 0 indicated the criteria were not met, 0.5 was assigned if some but not all criteria were met, and 1 was assigned if the criteria were met fully. Other systematic reviews have also utilized partial scores (Reimann et al., 2018; McWhirter and Hoffman-Goetz, 2014). An article could receive “not applicable (NA)” or “not reported (NR)” if the criteria were not related to or described in that study. To account for this, the denominator for an article with NA or NR was decreased to include only applicable items. Appendix Table 1 details the critical appraisal tool. Appendix Table 2 presents each article's critical appraisal score. Critical appraisal scores ranged from 78% to 100%, (average = 88%) and did not lead to the exclusion of any articles.

3. Results

3.1. Study characteristics

Although there were no geographic restrictions in the search, all studies included in this review were conducted in the U.S. ($n = 7$). Of these studies, two studies included one state (Coups et al., 2016; Simmons et al., 2014), one study included two states (Blashill and Pagoto, 2017), one study included 32 states (Guy et al., 2014), one study included 34 states (Mayer et al., 2011), one study included 37

states (Qin et al., 2018), and one included a national scope (Cokkinides et al., 2009). All seven studies used an observational, cross-sectional design. Studies used in-person completion of questionnaires ($n = 5$) (Coups et al., 2016; Simmons et al., 2014; Blashill and Pagoto, 2017; Guy et al., 2014; Qin et al., 2018) and telephone surveys ($n = 2$) (Mayer et al., 2011; Cokkinides et al., 2009) to collect data. The population of interest for most of the studies were middle and/or high school students ($n = 5$) (Coups et al., 2016; Simmons et al., 2014; Blashill and Pagoto, 2017; Guy et al., 2014; Qin et al., 2018), with sample sizes ranging from $n = 1850$ to $n = 41,313$ students. Adolescent-caregiver pairs were the population of interest for two studies (Mayer et al., 2011; Cokkinides et al., 2009) and included sample sizes ranging from $n = 1196$ to $n = 6125$ pairs.

3.2. Study outcomes

All seven studies measured the impact of indoor tanning legislation on prevalence (whether participants used an indoor tanning device at least once in the past year), and one study also measured frequency (number of times an individual used an indoor tanning device in the past year), of indoor tanning by youth. These studies made several comparisons: the differences in prevalence of youth indoor tanning before and after the implementation of legislation ($n = 3$) (Coups et al., 2016; Simmons et al., 2014; Blashill and Pagoto, 2017); the prevalence of youth indoor tanning in states with and without legislation ($n = 4$) (Guy et al., 2014; Mayer et al., 2011; Qin et al., 2018; Cokkinides et al., 2009); and the prevalence of youth indoor tanning in states with newly implemented legislation (1–6 years prior) and in states with longer standing legislation (7–17 years prior) ($n = 2$) (Blashill and Pagoto, 2017; Cokkinides et al., 2009). These comparisons and corresponding differences in youth indoor tanning prevalence are shown in Table 2. In addition, the prevalence of indoor tanning relative to policy type (i.e., parental permission vs. complete age restriction) was compared ($n = 2$) (Guy et al., 2014; Qin et al., 2018).

3.3. Before and after legislation

Three studies investigated the differences in indoor tanning prevalence by youth before and after the implementation of age restriction legislations (Coups et al., 2016; Simmons et al., 2014; Blashill and Pagoto, 2017). In general, there was a decrease in youth indoor tanning prevalence after the implementation of legislation; however, this was not always statistically significant. All three studies stratified youth by gender. Among female youth, indoor tanning prevalence consistently decreased after the implementation of indoor tanning legislation (one was a statistically significant decrease). Among male youth, indoor tanning prevalence decreased in two studies (one was a statistically significant decrease) and increased in one study (not statistically significantly different).

One study found a significant decrease in youth indoor tanning when averaged across gender (12% before to 8% after) (Simmons et al., 2014). When youth were stratified by gender in that study, both female and male indoor tanning prevalence decreased statistically significantly by 6% and 2%, respectively (Simmons et al., 2014). A second study found non-significant decreases in indoor tanning prevalence (Blashill and Pagoto, 2017). When youth were stratified by gender, female indoor tanning prevalence numerically decreased by 2%, while male indoor tanning prevalence numerically decreased by 3% (Blashill and Pagoto, 2017). A third study found no change in youth indoor tanning before and after implementation of age restriction legislation (7% both before and after legislation) (Coups et al., 2016). When youth were stratified by gender, female indoor tanning prevalence numerically decreased by 2%, while male indoor tanning prevalence numerically increased by 3%, although these differences were not statistically significant (Coups et al., 2016). This small increase for males was anomalous among the results.

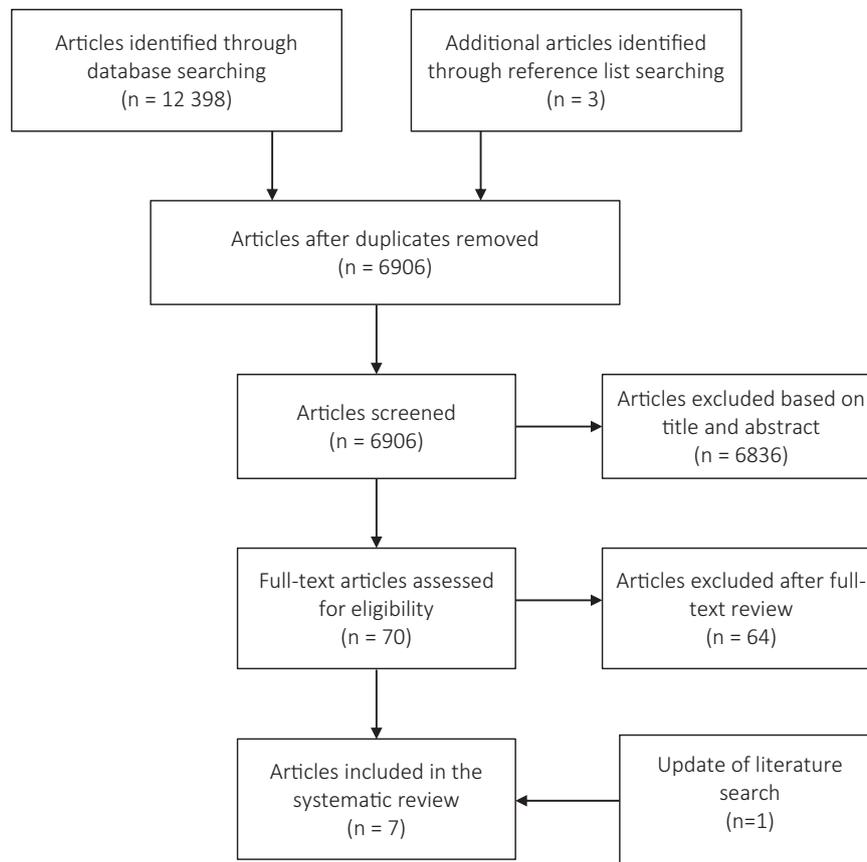


Fig. 1. Flow chart for the search and selection of studies.

3.4. State-to-state legislation comparison

Four studies reported the differences between the prevalence of youth indoor tanning in states with legislation addressing youth use of indoor tanning, compared to states without such legislation (Guy et al., 2014; Mayer et al., 2011; Qin et al., 2018; Cokkinides et al., 2009). All four studies found a lower past year prevalence of youth indoor tanning in states with indoor tanning legislation compared to states without indoor tanning legislation; however, not all were statistically significant.

One study reported a numerical difference in past year prevalence of youth indoor tanning in states with indoor tanning legislation compared to states without indoor tanning legislation in 1998 (8% with vs 9% without) and then again in 2004 (10% with vs 13% without) (Cokkinides et al., 2009); however, these findings were not statistically significant. A second study reported the past year prevalence of youth indoor tanning in states with indoor tanning legislation addressing minors' use was 3% lower than the prevalence of youth indoor tanning in states without indoor tanning legislation addressing minors' use (Mayer et al., 2011). However, in the multivariable analysis, the association between the presence of indoor tanning legislation and the prevalence of youth indoor tanning was no longer significant (Mayer et al., 2011).

Two studies reported statistically significant differences in the prevalence of past year indoor tanning in states with indoor tanning legislation compared to states without indoor tanning legislation (Guy et al., 2014; Qin et al., 2018). Guy et al. (2014) reported the prevalence of female youth indoor tanning in states with any indoor tanning legislation was 9% lower than the prevalence of female youth indoor tanning in states without indoor tanning legislation (Guy et al., 2014). Further, the prevalence of female indoor tanning was lowest in states with legislations that had systems access (warning statements and signs,

restricted advertising, mandatory protective eyewear, operator incident reports, and penalties for violation), parental permission (laws that prohibit minors younger than a certain age without parental consent or accompaniment), and age restrictions compared to states without any laws (Guy et al., 2014). Indoor tanning prevalence for males in this study was 1% lower in states with legislation compared to those without, but this was not statistically significant (Guy et al., 2014). Qin et al. (2018) reported the prevalence of past year female youth indoor tanning was 25% in states with no legislation, 20% in states with parental permission legislation, and 7% in states with age restriction legislation (Qin et al., 2018). This trend of lower prevalence was statistically significant. Additionally, the adjusted prevalence of indoor tanning was statistically significantly lower by 47% among females affected by age restriction legislation, compared to females not affected by any indoor tanning legislation (Qin et al., 2018). They also reported numerically lower past year prevalence of male youth indoor tanning in states with varying age restriction legislations. The prevalence of past year male youth indoor tanning was 6% in states with no legislation, 5% in states with parental permission legislation, and 3% in states with age restriction legislation, but this difference was not statistically significant (Qin et al., 2018).

3.5. Policy type

Two studies evaluated policy type (Guy et al., 2014; Qin et al., 2018) by examining indoor tanning prevalence where legislations allow for parental permission (i.e., age restriction is present, but minors can indoor tan with parental permission) relative to no legislation or a complete age restriction. These studies found the prevalence of female youth indoor tanning in states with indoor tanning legislation (systems access, parental permission), but without a complete age restriction, was no different than the prevalence in states without indoor tanning

Table 1
Overview of studies.

Authors (year)	Country (state)	Date of data collection	Legislation	Methods (sample size)	Population of interest	Key findings
Blashill and Pagoto (2017) ^a	U.S. (AL, FL)	2013 & 2015	State	In-person multiple-choice survey (N = 14,389)	High school students (grades 9–12)	Prevalence of use: In Alabama, in 2013, before the youth ban, the prevalence of female past year indoor tanning was 27%, which decreased to 26% in 2015, after the ban. In 2013, before the ban, the prevalence of male past year indoor tanning was 13%, which decreased in 2015 to 11%, after the ban. None of these differences were statistically significant. Both female and male youth in Alabama reported higher indoor tanning rates than youth in Florida (comparison state). This occurred before and after legislation was implemented in Alabama in 2014 (females: 2013 AL = 27%, FL = 8%; 2015 AL = 26%, FL = 6%) (males: 2013 AL = 13%, FL = 6%; 2015 AL = 11%, FL = 6%).
Cokkinides et al. (2009)	U.S. (50 states)	1998 & 2004	State	Telephone survey (1998: N = 1196) (2004: N = 1613)	Adolescent (ages 11–18) and caregiver pairs	Prevalence of use: In 1998, prevalence of past year indoor tanning in states with legislation was 8% compared to states without legislation where it was 9%. In 2004, prevalence of past year indoor tanning in states with indoor tanning legislation was 10% compared to states without legislation where it was 13%. These findings were not statistically significant. Frequency of use: There were no statistically significant differences in the frequency of indoor tanning from 1998 to 2004, whether there was an age restriction legislation or not.
Coups et al. (2016)	U.S. (NJ)	2012 & 2014	State	In-person multiple-choice survey (2012: N = 1850) (2014: N = 3909)	High school students	Prevalence of use: Overall, in 2012 before the youth ban, the prevalence of youth past year indoor tanning was 7%, which did not change in 2014, after the ban. In 2012, before the youth ban, the prevalence of female past year indoor tanning was 8%, which decreased to 6% in 2014, after the ban. In 2012, before the ban, the prevalence of male past year indoor tanning was 5%, which increased to 8% in 2014, after the ban. None of these differences were statistically significant.
Guy et al. (2014) ^a	U.S. (32 states)	2009 & 2011	State	In-person multiple-choice survey (N = 25,758)	High school students (grades 9–12)	Prevalence of use: Overall, 23% of females participated in indoor tanning, with a lower prevalence in states with indoor tanning legislations than states without indoor tanning legislations (21% vs 30%; $p = 0.03$). The lowest prevalence of female indoor tanning was in states with legislation including age restrictions (17%). These findings were statistically significant. Overall, 6% of males participated in indoor tanning, with no significant difference in the prevalence of indoor tanning in states with indoor tanning legislations compared to states without indoor tanning legislations (6% vs 7%; $p = 0.70$). The prevalence of male indoor tanning was 6% in states with legislation including age restrictions. These findings were not statistically significant.
Mayer et al. (2011)	U.S. (34 states & DC)	2005	State	Telephone survey (N = 6125)	Adolescent (ages 14–17) and caregiver pairs	Prevalence of use: Prevalence of past year indoor tanning use in states with legislation addressing youth use was 9%, compared to prevalence of past year indoor tanning use in states without legislation was 12%. These findings were not statistically significant.
Simmons et al. (2014)	U.S. (UT)	2011 & 2013	State	In-person multiple-choice survey (2011: N = 15,609) (2013: N = 15,184)	Middle and high school students (grades 6, 8, 10, and 12)	Prevalence of use: Overall, the prevalence of youth past-year indoor tanning significantly decreased from 12% in 2011 to 8% in 2013, after legislation compared to before ($p < 0.0001$). Female indoor tanning prevalence significantly decreased from 18% to 12% ($p = 0.002$), while male indoor tanning prevalence significantly decreased from 6% to 4% ($p = 0.002$). These findings were statistically significant.

(continued on next page)

Table 1 (continued)

Authors (year)	Country (state)	Date of data collection	Legislation	Methods (sample size)	Population of interest	Key findings
Qin et al. (2018) ^a	U.S. (37 states)	2009, 2011, 2013, 2015	State	In-person multiple-choice survey (N = 41,313)	High school students (grades 9–12)	Prevalence of use: Overall, 18% of females participated in past-year indoor tanning. The prevalence of female past-year indoor tanning was 25% among those not affected by age restriction legislation, 20% among those affected by parental permission legislation, and 7% among those affected by age restriction legislation ($p < 0.001$). The adjusted prevalence of indoor tanning was 47% lower among females affected by age restriction legislation, compared to females not affected by age restriction legislation (APR = 0.53; $p < 0.001$). Overall, 5% of males participated in past-year indoor tanning. The prevalence of male past-year indoor tanning was 6% among those not affected by age restriction legislation, 5% among those affected by parental permission legislation, and 3% among those affected by age restriction legislation.

^a These studies used the Youth Risk Behaviour Survey Data. They present different results from different states and different years.

legislation, suggesting complete age restriction legislation is key (Guy et al., 2014). Qin et al. (2018) reported the prevalence of youth indoor tanning was 13% lower among females (statistically significant), and 2% lower among males, in states with complete age restrictions compared to states with legislation that allow for parental permission (Qin et al., 2018). Guy et al. (2014) reported the prevalence of youth indoor tanning was 9% lower among females (statistically significant), and 2% lower among males, in states with age restriction legislations (and systems access and parental permission) compared to states with just systems access and parental permission (Guy et al., 2014).

3.6. New vs. long standing legislation

Two studies compared the prevalence of youth indoor tanning in U.S. states with newer legislation to states with longer standing legislation (Blashill and Pagoto, 2017; Cokkinides et al., 2009). These studies did not test for statistically significant differences, but both found numerically lower prevalence of youth indoor tanning in states with longer standing legislation. One study compared the prevalence of youth indoor tanning in Alabama (newer legislation) to the prevalence of youth indoor tanning in Florida (longer standing legislation) (Blashill and Pagoto, 2017). This study reported lower prevalence of indoor tanning in Florida where there was longer standing legislation, for both females (20% lower) and males (5% lower) (Blashill and Pagoto, 2017). The other study, conducted across 50 U.S. states, similarly found a numerically lower prevalence of youth indoor tanning in states with legislation implemented before 1997 compared to states with legislation implemented between 1997 and 2004 (8% for longer standing legislation vs 10% for newer legislation) (Cokkinides et al., 2009).

3.7. Frequency of use

One study investigated the frequency of indoor tanning use by youth relative to legislation. In this study, the average frequency of indoor tanning use by youth was six times per year. This frequency did not change significantly whether there was an age restriction legislation in effect (three times per year with longer-standing legislation, nine times per year with newer legislation) or no age restriction legislation in effect (five times per year) (Cokkinides et al., 2009).

4. Discussion

This systematic review of seven U.S.-based studies describes a lower trend in the prevalence of youth indoor tanning associated with indoor tanning legislation. This was true for comparisons before and after legislation, among states with and without legislation, for states with complete age restrictions (no parental permission), and for longer standing compared to newly implemented legislation. The percent differences in youth indoor tanning prevalence found in this review were, on average, small; however, the population level value equates to millions of youth not participating in indoor tanning. While the general trend of lower indoor tanning prevalence is very encouraging, the results also indicate youth are still indoor tanning across the U.S. despite prohibitive laws. Hence, though indoor tanning legislation is having some positive impact, it may not yet be having its full intended impact.

Effective indoor tanning legislations have the potential to significantly reduce skin cancer rates and health care costs. Results of a modelling study suggest that if all youth in the U.S. under 18 were banned from indoor tanning, and this was adhered to, 61,839 melanoma cases and 6735 melanoma deaths would be prevented, resulting in 142,659 life years saved, and \$342 million USD in melanoma treatment costs saved, over the lifetime of youth (Guy et al., 2016). The findings of this review suggest the results of these models cannot be fully realized. There may be ways to improve the effect of indoor tanning legislation, including through greater compliance and enforcement, increased legislative stringency, and attention to policy type.

Table 2
Summary of impact of legislation on prevalence of youth indoor tanning by comparison type.

Study (authors,date)	Comparison	Prevalence of youth indoor tanning before legislation	Prevalence of youth indoor tanning after legislation	Prevalence of youth indoor tanning without legislation (or new legislation)	Prevalence of youth indoor tanning in states with legislation (or longer standing legislation)	% difference
Simmons et al., 2014	Before vs after legislation	All: 12% Female: 18% Male: 6%	All: 8% Female: 12% Male: 4%	-	-	All: 4% decrease** Female: 6% decrease**
Coups et al., 2016	Before vs after legislation	All: 7% Female: 8% Male: 5%	All: 7% Female: 6% Male: 8%	-	-	Male: 2% decrease** All: 0% Change Female: 2% decrease Male: 3% increase Female: 1% decrease
Blashill and Pagoto, 2017 ^{a,b}	Before vs after legislation	Female: 27% Male: 13%	Female: 26% Male: 11%	-	-	Male: 2% decrease Female: 20% ^z
Cokkinides et al., 2009 ^c	State to state (2 states)	-	-	Female: 26% Male: 11%	Female: 6% Male: 6%	Male: 5% ^z 1998: 1% ^z 2004: 3% ^z
Mayer et al., 2011	State to state (34 states & DC)	-	-	Legislation before 1997: 10% All: 12%	Legislation between 1997 & 2004: 8% All: 9%	All: 2% ^z All: 3%
Guy et al., 2014 ^a	State to state (32 states)	-	-	Female: 30% Male: 7%	Female: 21% Male: 6%	Female: 9% [*] Male: 1%
Qin et al., 2018 ^a	State to state (37 states)	-	-	Female (no legislation): 25% Female (parental permission): 20% Male (no legislation): 6% Male (parental permission): 5%	Female (age restriction): 7% Male (age restriction): 3%	Female: No legislation to age restriction: 18%** Parental permission to age restriction: 13%** Male: No legislation to age restriction: 3% Parental permission to age restriction: 2%

Prevalence of youth indoor tanning was compared in two ways: 1. Prevalence before implementation of legislation compared to prevalence after legislation; 2. Prevalence in states with indoor tanning legislation compared to prevalence in states without indoor tanning legislation.

^a These studies used the Youth Risk Behaviour Survey Data. They present different results from different states and different years.

^b Compared prevalence of youth indoor tanning in a state with longer standing legislation (Florida) compared to a state with newer legislation (Alabama).

^c This study conducted two identical surveys, one in 1998 and one in 2004, to assess the prevalence of youth indoor tanning in states with legislation compared to the prevalence of youth indoor tanning in states without legislation at the time of each survey.

^z Statistical significance not tested.

^{*} Boldface indicates statistical significance $p < 0.05$.

^{**} Boldface indicates statistical significance $p < 0.001$.

Poor compliance with indoor tanning legislation reduces effectiveness, and therefore the impact (Guy et al., 2016). Compliance with age restriction legislations remains imperfect and varies considerably from jurisdiction to jurisdiction, as has been reported in previous research (Reimann et al., 2018). For example, 30% of indoor tanning facility employees stated that a 15-year old could indoor tan at their facility, directly non-compliant with Wisconsin's age restriction legislation in 2009 (Pichon et al., 2009). More recent research has found age compliance to be as high as 80–100% (e.g., CA, TX) in some states and as low as 50–60% in others (e.g., NC, DC) (Qin et al., 2018). A lack of inspection for age documentation and infrequent penalties for age restriction infractions may be contributing factors (Hickle et al., 2005; Mayer et al., 2008). As well, approximately half of the youth who use indoor tanning facilities are unaware of legislations intended to restrict their use (Diehl et al., 2013; Lee et al., 2013). Greater enforcement around age restrictions, and awareness of legislation, may lead to even higher age-related compliance and, in turn, greater impact.

There was a lower prevalence of youth indoor tanning in states with indoor tanning legislation compared to states without indoor tanning legislation. The mean difference in prevalence was 5% lower; however, statistical significance was not always achieved. There are a number of possibilities why these differences were not always statistically significant: the studies may not have had enough power to detect a significant difference; there may have been inadequate levels of compliance and poor enforcement of the legislations; and possibly that legislations are not working as intended (Guy et al., 2014; Mayer et al., 2011; Cokkinides et al., 2009). Despite the lack of statistical significance in some cases, the fact remains that even small changes in prevalence translate to reductions in risk exposure that are of public health significance. Further, in some cases, quite large changes were noted. The most recently published study included in this review, for example, reported larger changes in youth indoor tanning prevalence than earlier studies; the adjusted prevalence of female youth indoor tanning was 47% lower in states with age restriction legislation compared to states without any age restriction legislation (Qin et al., 2018). State-level indoor tanning legislation appears to be associated with lower indoor tanning prevalence among youth.

Reported prevalence of youth indoor tanning was also lower with longer standing indoor tanning legislation compared newer indoor tanning legislation. This has also been supported in some studies about compliance with indoor tanning legislation (Reimann et al., 2018; Choy et al., 2017; Hester et al., 2005). Hence, the time lapse between legislation implementation and impact evaluation should be considered carefully in research design. All studies evaluating changes in prevalence before legislation implementation compared to after legislation implementation evaluated the legislation one year after implementation (Coups et al., 2016; Simmons et al., 2014; Blashill and Pagoto, 2017). Measurable changes in prevalence of indoor tanning may take more than one year to emerge, and this may be a reason for the modest changes noted in this review. For example, one included study evaluating newer legislation relative to longer-standing legislation compared a time lapse of one year to a time lapse of 17 years, finding no significant change after one year (Blashill and Pagoto, 2017). Future research should investigate how to accelerate compliance for greater impact.

Prevalence of youth indoor tanning differed by gender. It is widely known that more females than males indoor tan (Guy et al., 2014; Mayer et al., 2011). Studies in this review described larger and more statistically significant impacts of legislation on youth indoor tanning prevalence for females relative to males. This may be because fewer males are indoor tanning to begin with, and male indoor tanning behaviour is often initiated at an older age (Guy et al., 2014; Lostritto et al., 2012). The numerical differences in male indoor tanning prevalence therefore are expected to be smaller. Although there was a larger numerical difference for females, the proportional difference for females and males was very similar. Both genders should continue to be

deterred from indoor tanning.

Although indoor tanning legislation generally resulted in lower prevalence of youth indoor tanning, it is unclear why only some studies reported statistically significant findings, while other studies, using the same methodology, did not. More specifically, one study found significant decreases in the prevalence of past year indoor tanning, following implementation of age restriction legislation (Simmons et al., 2014) and two studies found significantly lower prevalence of youth indoor tanning in states with indoor tanning legislation compared to states without legislation (Guy et al., 2014; Qin et al., 2018). It is possible that the study evaluating indoor tanning prevalence before and after legislation was implemented found significant decreases in indoor tanning prevalence after because the state investigated had relatively strict legislation (Simmons et al., 2014). In contrast, states evaluated in the other studies had more lenient legislations, including lower age restrictions (e.g., banning < 16 vs. < 18) and parental permission (Coups et al., 2016; Blashill and Pagoto, 2017). It is likely that stringent youth access restrictions are more effective at preventing youth indoor tanning; however, the somewhat conflicting results require further investigation.

The stringency of a state's indoor tanning legislation is important and influential (Guy et al., 2014; Mayer et al., 2011; Heilig et al., 2005). Stringency is a measure of the strictness of legislation through legislative components including age restrictions, enforcement, and penalties (Woodruff et al., 2007). One study included in this review provided national estimates of indoor tanning prevalence, finding the lowest prevalence of youth indoor tanning in states with the most stringent indoor tanning legislations (Mayer et al., 2011). Stringency in this case was determined by a score assigned based on a comprehensive set of criteria (minors' access, customer notification of risks, UV exposure control, equipment standards, facility operations, operator training, sanitation, enforcement, and penalties for violation) (Woodruff et al., 2007). Other research supports this: indoor tanning operators in a state with high penalties for non-compliance provided clients with better health risk information compared to states with less severe penalties (Heilig et al., 2005). More stringent legislation is needed for more significant impact. Future research would do well to explore which aspects of stringency are most impactful.

We attempted to determine the impact of policy type. For the studies where reporting and design made this feasible, parental permission was the policy type examined. Indoor tanning legislations with parental permission are more lenient, less restrictive, and not as effective as complete age restrictions (Simmons et al., 2014; Guy et al., 2014; Qin et al., 2018). In this sense, parental permission could be considered one element of legislative stringency. As noted in the results, two studies compared complete age restrictions to parental permission, finding lower prevalence of youth indoor tanning in states with complete age restrictions (Guy et al., 2014; Qin et al., 2018). This review included studies that evaluated many states with parental permission legislation, which may be one reason indoor tanning prevalence changed in some studies (and often only modestly) and not others. For example, Blashill and Pagoto (2017) found no difference in the prevalence of youth indoor tanning before and after implementing legislation allowing parental permission (Blashill and Pagoto, 2017), while Cokkinides et al. found a significant decrease (Simmons et al., 2014). Lower age restrictions coupled with parental consent appear ineffective in most cases (Cokkinides et al., 2009). These somewhat conflicting results, which may be due to the inclusion of different states and time periods, make it difficult to draw definitive conclusions about the best type of indoor tanning legislation but most of the evidence suggests parental permission is less impactful than complete age restrictions. States should remove parental permission laws in favour of age bans and, especially in states that continue to allow parental permission, parents must be informed about indoor tanning risks. Low parental knowledge is also associated with adolescent tanning and lack of parental knowledge of the risks of indoor tanning is common (Magee et al., 2007). Low

knowledge of indoor tanning health risks, coupled with state laws allowing parental consent for youth indoor tanning, likely results in lesser impact of indoor tanning legislation.

Although studies focused on prevalence of use, one study focused on frequency of indoor tanning use by youth. Researchers found the frequency with which individuals tan did not change (Cokkinides et al., 2009). This is of concern because of the dose-response relationship between UV radiation and skin cancer, especially starting at a young age (Whiteman et al., 2001). Further, high frequency of indoor tanning use is associated with skin burns (Cokkinides et al., 2009). More research is needed to determine what relationship, if any, exists between legislation and frequency of indoor tanning.

5. Conclusions

5.1. Limitations

Given that many countries have indoor tanning legislation, it is important to study and synthesize the impact of these legislations on prevalence of use in other jurisdictions outside of the U.S. We also only included studies that were written in English. Three studies in the review had some overlapping data but were retained because the results, years, and states evaluated differed.

Legislation content and stringency varied across jurisdictions. As well, studies differed in terms of methodology, location and dates of data collection, and populations of interest. Some studies were unclear about which states, corresponding legislations, and legislative elements were examined in their evaluations. Combined, these factors made evidence synthesis challenging and restrictive. In future work, researchers should more clearly indicate relevant legislations in effect at the time of the study, and the included states.

Our intention to understand the frequency of indoor tanning by youth relative to legislation was restricted by the inclusion of only one study on the topic. To gain a greater understanding of the frequency of indoor tanning by youth, more research is needed.

6. Conclusions

Overall, indoor tanning legislation was associated with a slight decrease in the prevalence of indoor tanning use by youth but did not eliminate youth tanning; however, small percent differences equate to millions of youth at the population level potentially avoiding a risky exposure. Variations in legislative impact may be due to differences in stringency of legislation or time lapse from implementation to evaluation, among other factors. Current indoor tanning legislations appear to be impactful, and the trends are in the right direction, but they may not yet be reaching their optimal effects. Complete age restrictions should be favoured over legislations that allow for parental permission. Improved knowledge of the legislations, more stringent legislations (e.g., no parental permission), greater compliance with and enforcement of legislations, and positive parental influence may contribute to more significant declines in indoor tanning by youth. Those concerned with disease prevention should advocate for stringent indoor tanning legislation.

Acknowledgments

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The findings and conclusions presented in this paper are those of the authors and do not necessarily reflect the views of the University of Guelph. Author tasks were as follows: Jessica Reimann and Dr. Jennifer McWhirter had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Reimann, McWhirter, Papadopoulos, Dewey. Acquisition, analysis, and interpretation of data: Reimann, Cimino.

Drafting of the manuscript: Reimann, McWhirter, Cimino, Papadopoulos, Dewey. Critical revision of the manuscript for important intellectual content: Reimann, McWhirter, Papadopoulos, Dewey. All authors have reviewed and approved the final version of the manuscript. Article contents have been previously presented at conferences. No financial disclosures were reported by the authors of this paper. Conflicts of interest: none.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpmed.2019.03.041>.

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