

1 **Title Page**

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3 **Title:** Population-based Assessment of Antibiotics Prescribing by Dentists in Manitoba – A Longitudinal
4 Analysis

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33

34 **Abstract**

35

36 **Background:**

37 Antibiotic surveillance/stewardship programs have become important tools to promote optimal antibiotic
38 use. Dental prescribing of antibiotics is a significant contributor to overall antibiotic use but has received
39 limited assessment and review at the population level.

40 **Methods:**

41 Antibiotic prescriptions dispensed from 2014-2019 were evaluated in this longitudinal population-based
42 study conducted in Manitoba, Canada. Antibiotic rates were adjusted for population numbers (per 1000
43 persons). Linear regression was used to assess trends over time for dentists and physicians.

44 **Results:**

45 Over the study period, 405,124 antibiotic prescriptions written by dentists were dispensed, representing
46 9.1% of all antibiotic prescriptions. Physician antibiotic prescribing dropped over time while dentist
47 prescribing remained unchanged (60.1 prescriptions/1000 persons). More than a quarter (27.0%) had
48 potentially inappropriate durations longer than a week.

49 Penicillins were most commonly prescribed (amoxicillin (64.1%), penicillin V (15.0%)). While limited
50 prescriptions were written for the broader spectrum amoxicillin/clavulanate (1.9%), there was a modest
51 increase over time of 12.5% per year ($p < 0.0015$).

52 Analysis by region and income showed relatively consistent results except for northern remote regions
53 where higher rates of dental prescribing were seen.

54 **Conclusions:**

55 Dental prescribing of antibiotics in Manitoba is stable but higher than national averages with some
56 indications of increased use of broad-spectrum antibiotics. This is in contrast to a significant decline of
57 overall antibiotic prescribing by physicians.

58 **Practical Implications:**

59 Current data suggest that limiting prescription duration, evaluating the need for a prescription, and
60 increasing scrutiny of the need for broad-spectrum antibiotics may improve the overall quality of dental
61 antibiotic prescribing.

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65 **Keywords:** Antibiotics, Dentists, Prescribing, antibiotic stewardship

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67 **Background**

68 Antibiotic resistance is considered a serious threat to global public health by the World Health
69 Organization (WHO). Increasing resistance rates to common infections have been observed worldwide,
70 highlighting a need for antibiotic surveillance and stewardship programs.¹ Across North America there
71 have been a variety of action plans over the past decade seeking to address the problem of
72 antimicrobial resistance by focusing on surveillance, stewardship, and innovation.^{2,3} The appropriateness
73 of dental use of antibiotics has been brought into question as a potential problem considering increasing
74 resistance rates and a lack of treatment guidelines.⁴ However, despite dentists accounting for 3-13% of
75 all antibiotic prescribing,⁵⁻⁹ these programs and recommendations often fail to include dentists or focus
76 only on hospital dental practice.^{10,11} Studies looking at dental prescribing have found increasing rates in
77 North America (United States and Canada)^{8,12} but decreasing rates have been found in England and
78 Australia.^{7,9}

79 Limited guidelines for antibiotic prescribing in dentistry as well as slow or incomplete application of
80 existing guidelines have been suggested as a reason for inappropriate antibiotic initiation amongst
81 dentists.^{5,6,8,13,14} Choice of therapeutic antibiotic and duration is another area lacking clear guidance.¹⁵
82 While various reviews highlight penicillin V as a preferred option due to its narrow spectrum and the lack
83 of evidence of amoxicillin superiority,^{16,17} the broader spectrum amoxicillin is more commonly
84 prescribed.^{6-9,13} The American Association of Endodontics (AAE) states that practitioners should
85 minimize the use of broad spectrum antibiotics.¹⁸ However, both the AAE and the ADA prefer
86 amoxicillin over penicillin V due to its broader spectrum and more favorable dosing interval.^{18,19}
87 Although the ADA does list penicillin V as an alternative first line agent.

88 In this paper, the population level data (Manitoba, Canada) for all filled antibiotic prescriptions written
89 by dentists over a 5-year period was examined. The aim of our study was to evaluate the trends in

90 antibiotic prescribing by dentists and consider the impact of the focus on antibiotic stewardship on
91 current dental antibiotic prescribing.

92 **Methods**

93 Antibiotic prescribing by dental professionals in the Province of Manitoba, Canada was assessed for the
94 interval between April 1, 2014 and March 31, 2019. Administrative health care data including
95 prescription dispensation records and the Manitoba Health registry were evaluated using a serial cross-
96 sectional design. Trends in dentist prescribing patterns were contrasted with those of physicians over
97 the same time.

98 Manitoba has a universal health care system, with all physician visits and hospitalizations provided at no
99 cost. While dental services are not covered by the system, prescriptions written by dentists are either
100 paid directly by patients, covered by private insurance, or fully covered by public insurance once
101 individuals have paid their annual, income-based deductible. The administrative data generated is
102 gathered and stored in the Manitoba Population Research Data Repository, which has been previously
103 described in the literature and is used extensively for health, social science, education, and justice
104 research.^{20,21}

105 As dental services are not covered by the Manitoba health care system, the data on services rendered
106 are not collected and stored in the Data Repository. However, dispensed prescriptions written by
107 dentists, as with all other prescriptions, are collected and can be distinguished from prescriptions
108 written by other health care professionals. All individual level data stored in the repository contains a
109 unique, scrambled identifier allowing for the cross-linking of data across the many databases available.

110 Oral antibiotic prescriptions dispensed in the province during the study period were identified using ATC
111 codes starting with "J01" or with the code "P01AB01", which is an alternative ATC code for
112 metronidazole. The days supply field was used to describe the distribution of antibiotic treatment

113 length. Prescriptions were classified by prescriber into four categories: dentist, physician, nurse
114 practitioner, or other (pharmacists, midwives, optometrists, and unknown). Rates of antibiotic use were
115 adjusted for population numbers and expressed as units per 1000 persons.

116 Antibiotic prescriptions were also broken down into mutually exclusive categories based on drug or drug
117 class. These categories were amoxicillin alone, penicillin, clindamycin, amoxicillin/clavulanate,
118 macrolides, metronidazole, and miscellaneous. Numbers of prescriptions for each category were
119 summarized by year.

120 User demographics, including age, sex, and geography were determined using the Manitoba Health
121 registry. Postal codes were used in conjunction with Canada census data to assign individuals to income
122 quintiles based on the average neighborhood income of each user.

123 Descriptive statistics were used to summarize rates of use and changes between 2014/15 and 2018/19.

124 Ordinary linear regression was used to assess trends in antibiotic prescribing by physicians and dentists,
125 as well as to test for trends over time in the use of individual drug classes.

126 **Results**

127 Over the period of April 2014 – March 2019, 4,452,767 oral antibiotic prescriptions were dispensed by
128 community pharmacies in Manitoba (approximately 890,000 per year, population 1,369,852 in 2018).

129 There were 405,124 dentist prescriptions accounting for 9.1% of the antibiotics dispensed during the
130 study period, with physicians accounting for 87.0%, nurse practitioners 3.7%, and other prescribers

131 contributing the remaining 0.2%. Overall, a 4.4% decrease in prescriptions was seen from 2014/15 to
132 2018/19, despite the population in the province increasing by 4.1% over the same period. Breaking

133 down rates of antibiotic prescriptions by prescriber type reveals that the decline was driven by a

134 significant drop in physician antibiotic prescribing over time ($\beta = -13.21$, $t=-5.33$ $p<0.05$; $R^2=0.90$) (Figure

135 1). The rate of dental prescribing, meanwhile, was virtually unchanged over the study period ($\beta = -$

136 0.321, $t=-0.82$ $p=0.47$; $R^2=0.18$). Overall, the annual rate of dental prescribing of antibiotics averaged
137 60.1 prescriptions per 1000 people. Men (56.8 prescriptions per 1000 persons) had significantly lower
138 annual rate than women (63.3 prescriptions per 1000 persons)($p < 0.0001$). There was also significant
139 variation in the annual dental prescribing by age ($\leq 18 - 25.8$, 19 to 40 – 63.1, 41 to 59 76.7, ≥ 60 74.6
140 prescriptions per 1000 people; ANOVA $F=1182$, $p<0.0001$).

141 The majority (65.2%) of prescriptions had durations of 3 days to 7 days (56.1%). A small percentage
142 (7.8%) of the prescriptions were for only 1 or 2 days and may have been indicated for prophylaxis. Over
143 a quarter of the prescriptions (27.0%) were written for durations longer than 7 days (Figure 2).

144 As a class, penicillin antibiotics accounted for the overwhelming majority of dental antibiotic
145 prescriptions accounting for 81.0% of all dental antibiotics prescribed during the study. Amoxicillin was
146 the most commonly prescribed antibiotic (64.1%) followed by penicillin V (15.0%), and clindamycin
147 (12.1%) (Figure 3). There were modest but non-significant increases in amoxicillin (62.0% to 66.8%) and
148 non-significant declines in penicillin V prescribing (15.9% to 12.8%) as a proportion of the total over
149 time. While use was relatively low (1.9%), the proportion of dental antibiotic prescriptions for
150 amoxicillin/clavulanate increased over time (1.7% to 2.4%). In relative terms, this translates to
151 approximately a 12.5% ($\beta =0.10$, $t=3.23$ $p<0.05$; $R^2=0.78$) increase in amoxicillin/clavulanate prescribing
152 per year. Of note, physician prescribing of amoxicillin/clavulanate also increased by approximately
153 10.6% per year ($\beta =2.89$, $t=11.17$ $p<0.0015$, $R^2= 0.98$) during the study. For macrolides, the overall
154 proportion of antibiotic prescribing was 2.9%, but this declined during the study from 3.3% to 2.5%. In
155 relative terms, this represents a decrease of approximately 6.2% per year ($\beta =-0.13$, $t=-21.17$ $p<0.001$;
156 $R^2=0.99$) in macrolide prescribing. The most common macrolide prescribed was azithromycin (62.5%)
157 followed by erythromycin (29.3%) and clarithromycin (8.2%).

158 An analysis of the rate of dental antibiotic prescriptions was conducted by region and the income
159 quintile of the patients. In most regions, there was little difference in the rate of dental prescribing by
160 income quintile and no appreciable change over time. However, the Northern Region showed higher
161 prescribing rates, considerable variation in the rate of antibiotic prescribing by income quintile and a
162 modest increase in the rate of antibiotic prescribing over time (Figure 4).

163 **Discussion**

164 From April 2014 through March 2019, Manitoba dentists prescribed 9.1% of all outpatient antibiotics.
165 While physician prescribing of antibiotics declined during this period, there was no significant decline in
166 dental prescriptions. Amoxicillin was the most commonly prescribed antibiotic. While the use of narrow
167 spectrum penicillin V trended downward, there was a significant increase in the prescribing of
168 amoxicillin/clavulanate during the study period. Overall, the results are not alarming but suggest that
169 there may be room for improvement in antibiotic stewardship in dental prescribing. It is concerning that
170 there was no evidence of the decline in dental antibiotic usage as seen with physician antibiotic
171 prescribing. In addition, antibiotic stewardship programs encourage the use of narrow spectrum first-
172 line agents, so even a modest increase in the use of the broad spectrum amoxicillin/clavulanate is an
173 area of potential concern. Prescription duration was also mostly ≤ 7 days as recommended,^{16,19} but more
174 than a quarter were for durations of longer than 7 days, which is another area of concern.

175 The overall stable level of antibiotic prescribing found in this study can be contrasted to an assessment
176 conducted in British Columbia, Canada where a greater decrease in physician prescribing was seen (18%
177 decline) and dental antibiotic prescribing was increasing (62% increase).⁸ However, the British Columbia
178 study considered a time period (1996 to 2013) prior to the start of this study. The Canadian
179 Antimicrobial Resistance Surveillance System Report also reported a rise in dental antibiotic prescribing
180 from 31.3 prescriptions per 1,000 inhabitants in 2010 to 48.2 in 2014.²² However, similar to what was

181 found in this study, dental antibiotic prescribing was relatively stable from 2014 to 2018 with a
182 prescribing rate of 48.5 prescriptions per 1,000 inhabitants in 2018.²³ Data from the reports also show
183 that on a national level, dentists provided 4.7% of outpatient antibiotic prescriptions in 2010. This
184 peaked in 2014 with dentists prescribing 7.7% of antibiotics and remained stable with a rate of 7.4% in
185 2018.^{22,23} Comparatively for the 2014-2019 period, Manitoba dentists prescribed more antibiotics both
186 as percentage of total antibiotic prescribing (9.1% Manitoba vs. 7.4% Canada) and as a population-
187 adjusted rate (60.1 Manitoba vs. 48.5 Canada in prescriptions/1000 people).

188 Study of dental antibiotic prescribing in the United States has shown some indications of a rise in
189 antibiotic prescribing with one study showing a small rise from 1996 to 2013 with an adjusted odd ratio
190 of 1.10.¹² However, both stable rates (2013-2015) and decreasing rates (2005-2010) have also been
191 reported.^{24,25} Internationally, England and Australia have both reported decreasing dental prescribing for
192 2010-2017 and 2013-2016, respectively.^{7,9}

193 Across the populations of the countries studied above, amoxicillin dominates dental prescribing
194 accounting for 56-79% of antibiotic prescriptions.^{6-9,13} While this study found penicillin V and clindamycin
195 to be the next more commonly prescribed, drug choice after amoxicillin varied across jurisdictions. A U.S.
196 study and the Canadian British Columbia study found clindamycin and penicillin V to be the second and
197 third most frequently prescribed antibiotic by dentists.^{8,13} However, the next most common antibiotics
198 were metronidazole and amoxicillin/clavulanate in Australia, and metronidazole and erythromycin in
199 England.^{7,9} A concerning increase in amoxicillin/clavulanate prescriptions was also noted in several
200 studies.⁷⁻⁹ Dental coverage and accessibility might differ considerably between jurisdictions, which may
201 have considerable effects on the prescribing habits of dentists and impact the validity of comparisons
202 across regions.

203 The higher level of dental antibiotic prescribing found in this study is of some concern given the global
204 imperative to reduce and optimize antibiotic use.¹ One possible explanation for this could be more
205 people seeking emergency dental care instead of regular dental care in the province. Most dentists in
206 Manitoba are graduates of the University of Manitoba DMD program, it is possible that antibiotic
207 stewardship is not emphasized as strongly in the curriculum as other schools. Although we were unable
208 to directly assess appropriateness, improper prescribing has the potential to be a significant contributor
209 to the total number of dental antibiotics. In a 2017 survey in British Columbia, at least 30% of 116
210 general dentist and 36 endodontist respondents would prescribe antibiotics for the 6 of 7 scenarios in
211 which antibiotics were not indicated.¹⁴

212 We estimated about 7.8% of dental antibiotics were prescribed for prophylaxis. Data limitations
213 prevented a detailed assessment of the appropriateness of these prescriptions. However, a 2015 survey
214 of Alberta dentists and dental hygienists on the 2007 AHA infective endocarditis prophylaxis guidelines
215 found heterogeneous results, with some respondents prescribing for procedures or conditions that did
216 not warrant prophylaxis and others failing to prescribe when indicated. Suggested reasons included
217 prescriber disagreement with guidelines, guideline vagueness, or difficulty remembering guidelines.²⁶

218 Patient or physician preference is also cited as a reason for continued prophylaxis when not indicated.
219 Given these results, it seems likely that over-prescribing of antibiotics may be occurring in dentistry and
220 suggests a need for ongoing support, guidance, and guideline application approaches for dental
221 antibiotic prescribing. In 2019, the ADA released a clinical practice guideline on antibiotic use for pulpal
222 dental pain and intraoral swelling. Although the effect of these guidelines on prescribing is not yet
223 known, the implementation of guidelines can have a profound impact on prescribing habits. After the
224 NICE 2008 guidelines were introduced recommending the cessation of antibiotic prophylaxis for
225 infective endocarditis prevention in England, there was a 78.6% reduction in prophylaxis prescriptions
226 over the following 24 months.²⁷ Antibiotic prophylaxis for third molar extraction and implant placement

227 is common practice but remains controversial.²⁸ Further studies and guidance on the use of antibiotics
228 in periodontal surgery, oral surgery, extractions, and implant placement may also help reduce
229 unwarranted antibiotics. It is worth noting that the Canadian Association of Hospital Dentists and
230 Choose Wisely Canada have developed a resource that includes clear language on antimicrobial
231 stewardship (<https://choosingwiselycanada.org/hospital-dentistry/>).

232 In most regions, there was little impact of income on the rate of dental antibiotic prescribing. The
233 Northern Region, however, showed higher antibiotic prescribing, an increase in prescribing over time,
234 and rates that differed by income quintile. This area would be characterized as rural and remote and is
235 known to have more limited access to dental service with few dental specialists. One possible
236 explanation for this could be the use of antibiotics in lieu of definitive dental treatment or to manage
237 infections in emergency style dentistry due to irregular access to dental services. In support of this idea,
238 the COVID-19 pandemic limited access to dental services around the world. Data from England suggest
239 that this limited access was associated with an increase in dental antibiotic prescribing by 25%.²⁹ In
240 Australia, however, this pandemic period of limited access was associated with a 16% decrease in
241 antibiotic prescribing.³⁰ Further investigation is required to evaluate the relationship between income,
242 access and dental antibiotic prescribing.

243 This study has a number of strengths and limitations. A strength of this study is the ability of the
244 Manitoba Centre for Health Policy Repository to capture all filled prescriptions at community
245 pharmacies with the Drug Program Information Network (DPIN), allowing for the use of complete
246 population-level data for a full 5 years. The study was also able to assess dental antibiotic prescribing by
247 income quintile. We believe this is a novel finding and may offer insight to prescribing patterns and
248 access in rural/remote and underserved areas. There are also important limitations. The most
249 important is that dental care is not publicly funded in Canada and no diagnostic codes for dental work
250 are tracked in the provincial administrative data. Therefore, prescriptions from dentists cannot be linked

251 to a specific indication. In addition, there are no records of prescriptions written but not filled or of
252 antibiotics given in hospital. The study was also limited by the lack of antibiotic resistance information
253 to assess the appropriateness of broader spectrum antibiotics.

254 **Conclusion**

255 Dental prescribing of antibiotics in Manitoba is stable but higher than national averages with some
256 indication of increased use of broad-spectrum antibiotics. This is in contrast to a significant decline of
257 overall antibiotic prescribing by physicians. Further efforts are necessary to enhance the support of
258 dentists in the application of best practices related to the initiation, selection, and appropriate duration
259 of antibiotics.

260

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273 **References**

- 274 1. World Health Organization. *Global Action Plan on Antimicrobial Resistance.*; 2015. Accessed April
275 5, 2021. <https://www.who.int/publications/i/item/9789241509763>
- 276 2. Federal Task Force on Combating Antibiotic-Resistant Bacteria. *National Action Plan for*
277 *Combating Antibiotic-Resistant Bacteria.*; 2020. Accessed August 11, 2021.
278 [https://aspe.hhs.gov/sites/default/files/migrated_legacy_files//196436/CARB-National-Action-](https://aspe.hhs.gov/sites/default/files/migrated_legacy_files//196436/CARB-National-Action-Plan-2020-2025.pdf)
279 [Plan-2020-2025.pdf](https://aspe.hhs.gov/sites/default/files/migrated_legacy_files//196436/CARB-National-Action-Plan-2020-2025.pdf)
- 280 3. Public Health Agency of Canada. Pan-Canadian framework for action on antimicrobial resistance
281 and antimicrobial use. *Canada Commun Dis Rep.* 2017;43(11):217-219.
282 doi:10.14745/ccdr.v43i11a01
- 283 4. Oberoi SS, Dhingra C, Sharma G, Sardana D. Antibiotics in dental practice: how justified are we.
284 *Int Dent J.* 2015;65(1):4-10. doi:10.1111/idj.12146
- 285 5. Johnson TM, Hawkes J. Awareness of Antibiotic Prescribing and Resistance in Primary Dental
286 Care. *Prim Dent J.* 2014;3(4):44-47. doi:10.1308/205016814813877324
- 287 6. Durkin MJ, Hsueh K, Sallah YH, et al. An evaluation of dental antibiotic prescribing practices in the
288 United States. *J Am Dent Assoc.* 2017;148(12):878-886.e1. doi:10.1016/j.adaj.2017.07.019
- 289 7. Teoh L, Stewart K, Marino R, McCullough M. Current prescribing trends of antibiotics by dentists
290 in Australia from 2013 to 2016. Part 1. *Aust Dent J.* 2018;63(3):329-337. doi:10.1111/adj.12622
- 291 8. Marra F, George D, Chong M, Sutherland S, Patrick DM. Antibiotic prescribing by dentists has
292 increased. *J Am Dent Assoc.* 2016;147(5):320-327. doi:10.1016/j.adaj.2015.12.014
- 293 9. Thornhill MH, Dayer MJ, Durkin MJ, Lockhart PB, Baddour LM. Oral antibiotic prescribing by NHS
294 dentists in England 2010-2017. *Br Dent J.* 2019;227(12):1044-1050. doi:10.1038/s41415-019-
295 1002-3
- 296 10. The Communicable and Infectious Disease Steering Committee Task Group on Antimicrobial Use
297 Stewardship. *Antimicrobial Stewardship Final Report to the Public Health Network Council.*; 2016.
298 Accessed October 13, 2020. <http://www.phn-rsp.ca/pubs/anstew-gestan/index-eng.php>
- 299 11. Choosing Wisely Canada. Recommendations. Published 2020. Accessed August 24, 2021.
300 <https://choosingwiselycanada.org/recommendations/>
- 301 12. Okunseri C, Zheng C, Steinmetz CN, Okunseri E, Szabo A. Trends and racial/ethnic disparities in
302 antibiotic prescribing practices of dentists in the United States. *J Public Health Dent.*
303 2018;78(2):109-117. doi:10.1111/jphd.12245
- 304 13. Roberts RM, Bartoces M, Thompson SE, Hicks LA. Antibiotic prescribing by general dentists in the
305 United States, 2013. *J Am Dent Assoc.* 2017;148(3):172-178.e1. doi:10.1016/j.adaj.2016.11.020
- 306 14. Buttar R, Aleksejūnienė J, Coil J. Antibiotic and Opioid Analgesic Prescribing Patterns of Dentists
307 in Vancouver and Endodontic Specialists in British Columbia. *J Can Dent Assoc.* 2017;83:h8.
308 <http://www.ncbi.nlm.nih.gov/pubmed/29513210>
- 309 15. Fluent MT, Jacobsen PL, Hicks LA. Considerations for responsible antibiotic use in dentistry. *J Am*
310 *Dent Assoc.* 2016;147(8):683-686. doi:10.1016/j.adaj.2016.04.017

- 311 16. Gregoire C. Point of care: How are odontogenic infections best managed? *J Can Dent Assoc.*
312 2010;76(2):114-116. <https://jcda.ca/article/a37>
- 313 17. Stein K, Farmer J, Singhal S, Marra F, Sutherland S, Quiñonez C. The use and misuse of antibiotics
314 in dentistry. *J Am Dent Assoc.* 2018;149(10):869-884.e5. doi:10.1016/j.adaj.2018.05.034
- 315 18. American Association of Endodontists. AAE Position Statement. *J Endod.* 2017;43(9):1409-1413.
316 doi:10.1016/j.joen.2017.08.015
- 317 19. Lockhart PB, Tampi MP, Abt E, et al. Evidence-based clinical practice guideline on antibiotic use
318 for the urgent management of pulpal- and periapical-related dental pain and intraoral swelling. *J*
319 *Am Dent Assoc.* 2019;150(11):906-921.e12. doi:10.1016/j.adaj.2019.08.020
- 320 20. Roos LL, Brownell M, Lix L, Roos NP, Walld R, MacWilliam L. From health research to social
321 research: Privacy, methods, approaches. *Soc Sci Med.* 2008;66(1):117-129.
322 doi:10.1016/j.socscimed.2007.08.017
- 323 21. Jutte DP, Roos LL, Brownell MD. Administrative Record Linkage as a Tool for Public Health
324 Research. *Annu Rev Public Health.* 2011;32(1):91-108. doi:10.1146/annurev-publhealth-031210-
325 100700
- 326 22. Public Health Agency of Canada. *Canadian Antimicrobial Resistance Surveillance System 2017*
327 *Report.* Public Health Agency of Canada; 2018. [https://www.canada.ca/content/dam/phac-](https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/drugs-health-products/canadian-antimicrobial-resistance-surveillance-system-2017-report-executive-summary/CARSS-Report-2017-En.pdf)
328 [aspc/documents/services/publications/drugs-health-products/canadian-antimicrobial-resistance-](https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/drugs-health-products/canadian-antimicrobial-resistance-surveillance-system-2017-report-executive-summary/CARSS-Report-2017-En.pdf)
329 [surveillance-system-2017-report-executive-summary/CARSS-Report-2017-En.pdf](https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/drugs-health-products/canadian-antimicrobial-resistance-surveillance-system-2017-report-executive-summary/CARSS-Report-2017-En.pdf)
- 330 23. Public Health Agency of Canada. *Canadian Antimicrobial Resistance Surveillance System Report -*
331 *2020 Update.* Public Health Agency of Canada; 2020. [https://www.canada.ca/content/dam/hc-](https://www.canada.ca/content/dam/hc-sc/documents/services/drugs-health-products/canadian-antimicrobial-resistance-surveillance-system-2020-report/CARSS-2020-report-2020-eng.pdf)
332 [sc/documents/services/drugs-health-products/canadian-antimicrobial-resistance-surveillance-](https://www.canada.ca/content/dam/hc-sc/documents/services/drugs-health-products/canadian-antimicrobial-resistance-surveillance-system-2020-report/CARSS-2020-report-2020-eng.pdf)
333 [system-2020-report/CARSS-2020-report-2020-eng.pdf](https://www.canada.ca/content/dam/hc-sc/documents/services/drugs-health-products/canadian-antimicrobial-resistance-surveillance-system-2020-report/CARSS-2020-report-2020-eng.pdf)
- 334 24. Durkin MJ, Feng Q, Warren K, et al. Assessment of inappropriate antibiotic prescribing among a
335 large cohort of general dentists in the United States. *J Am Dent Assoc.* 2018;149(5):372-381.e1.
336 doi:10.1016/j.adaj.2017.11.034
- 337 25. Suda KJ, Roberts RM, Hunkler RJ, Taylor TH. Antibiotic prescriptions in the community by type of
338 provider in the United States, 2005-2010. *J Am Pharm Assoc.* 2016;56(6):621-626.e1.
339 doi:10.1016/j.japh.2016.08.015
- 340 26. Jain P, Stevenson T, Sheppard A, et al. Antibiotic prophylaxis for infective endocarditis. *J Am Dent*
341 *Assoc.* 2015;146(10):743-750. doi:10.1016/j.adaj.2015.03.021
- 342 27. Thornhill MH, Dayer MJ, Forde JM, et al. Impact of the NICE guideline recommending cessation of
343 antibiotic prophylaxis for prevention of infective endocarditis: before and after study. *BMJ.*
344 2011;342(may03 1):d2392-d2392. doi:10.1136/bmj.d2392
- 345 28. Singh Gill A, Morrissey H, Rahman A. A Systematic Review and Meta-Analysis Evaluating
346 Antibiotic Prophylaxis in Dental Implants and Extraction Procedures. *Medicina (Kaunas).*
347 2018;54(6):95. doi:10.3390/medicina54060095
- 348 29. Shah S, Wordley V, Thompson W. How did COVID-19 impact on dental antibiotic prescribing
349 across England? *Br Dent J.* 2020;229(9):601-604. doi:10.1038/s41415-020-2336-6

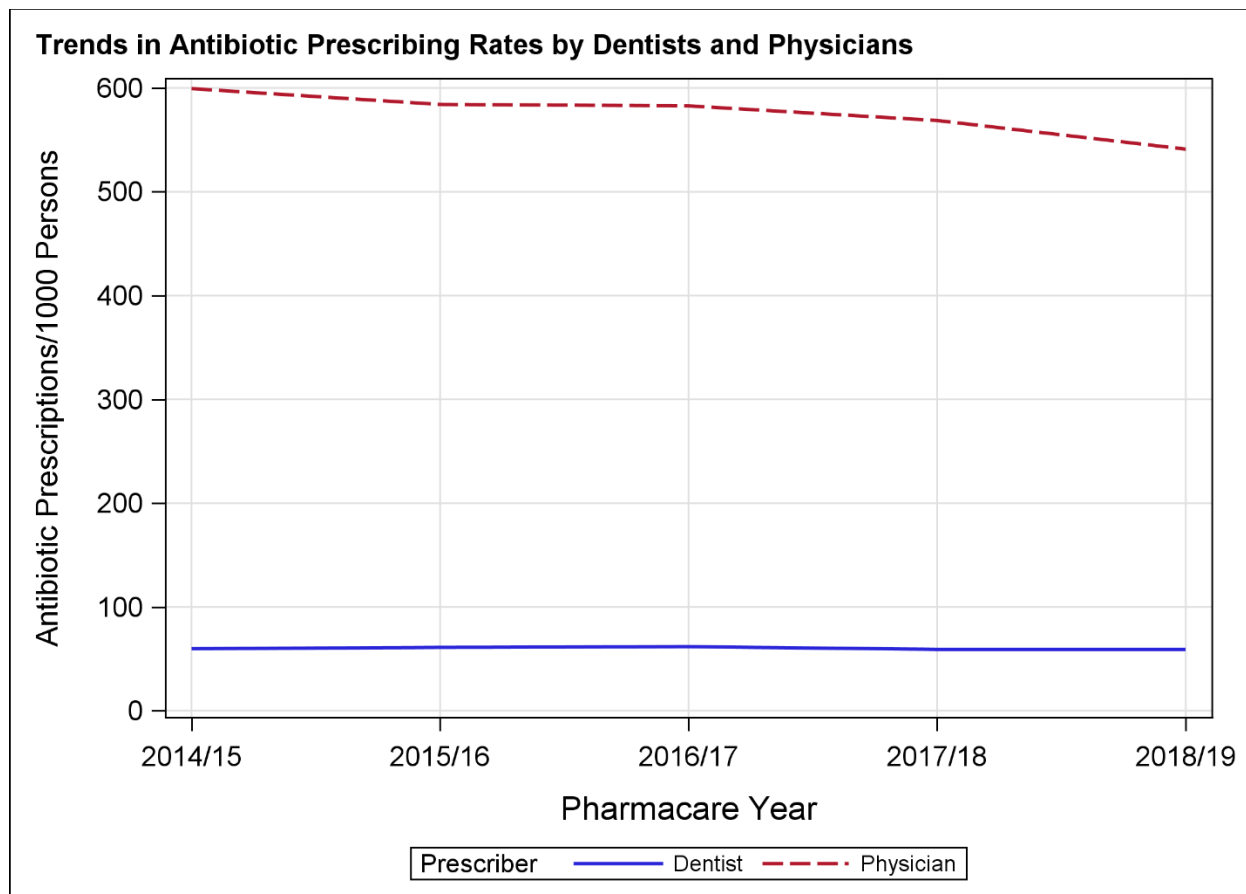
350 30. Mian M, Teoh L, Hopcraft M. Trends in Dental Medication Prescribing in Australia during the
351 COVID-19 Pandemic. *JDR Clin Transl Res*. 2021;6(2):145-152. doi:10.1177/2380084420986766

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354 Figure 1.

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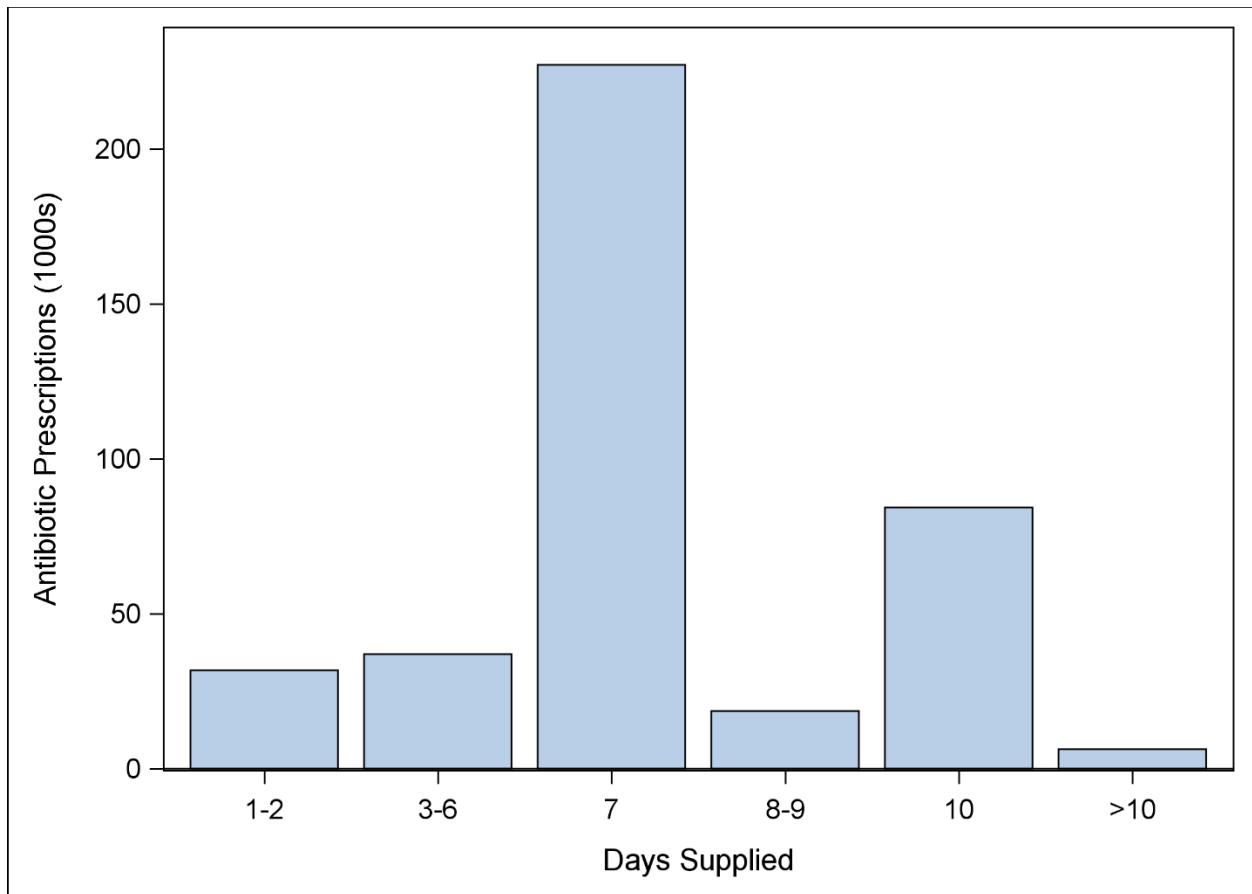
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368 Figure 2.

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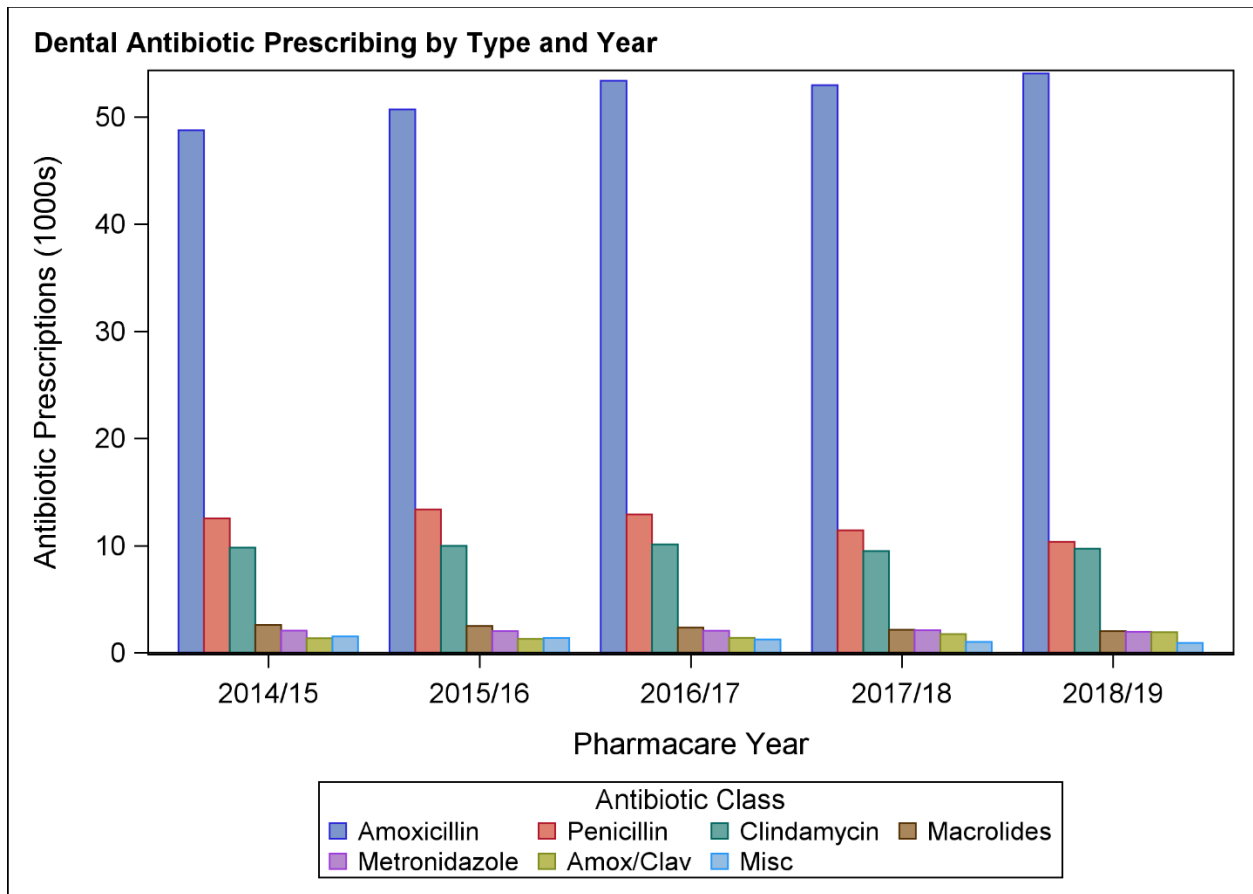
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382 Figure 3.

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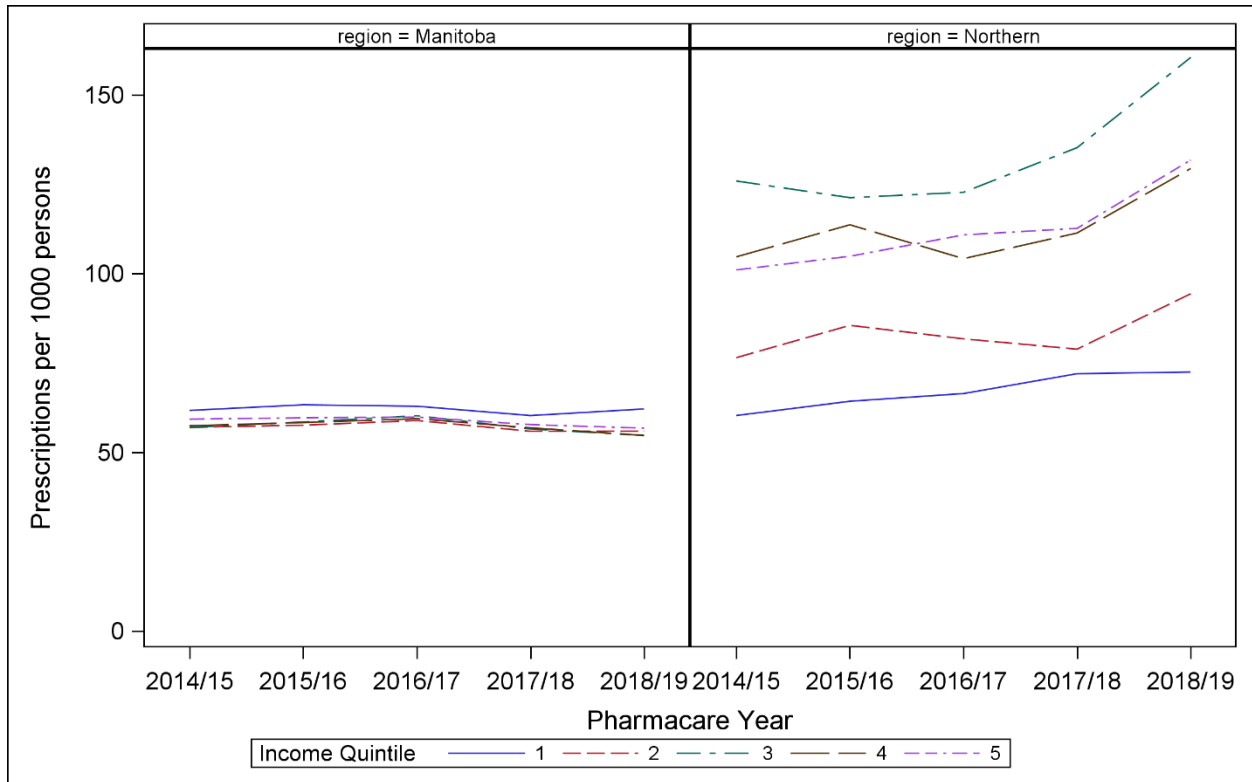
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396 Figure 4.

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398 **Antibiotic prescription rates by income quintile: Northern Manitoba vs rest of province. Income**
399 **quintiles are ordered from lowest (quintile 1) to highest (quintile 5) income level**



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