

Investigating the autism and ADHD prevalence in Chile through  
Bayesian prevalence analysis and clinical record data linkage

Student 5526

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This dissertation is submitted for the degree of Master of Philosophy. The dissertation does not exceed the word limit for the respective Degree Committee. Word count: xxx TODO

# 1 Abstract

TODO

# 2 Declaration

This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration except where specifically indicated in the text.

USN: xxxxx July, 2022

TODO - is this section needed?

# 3 Introduction

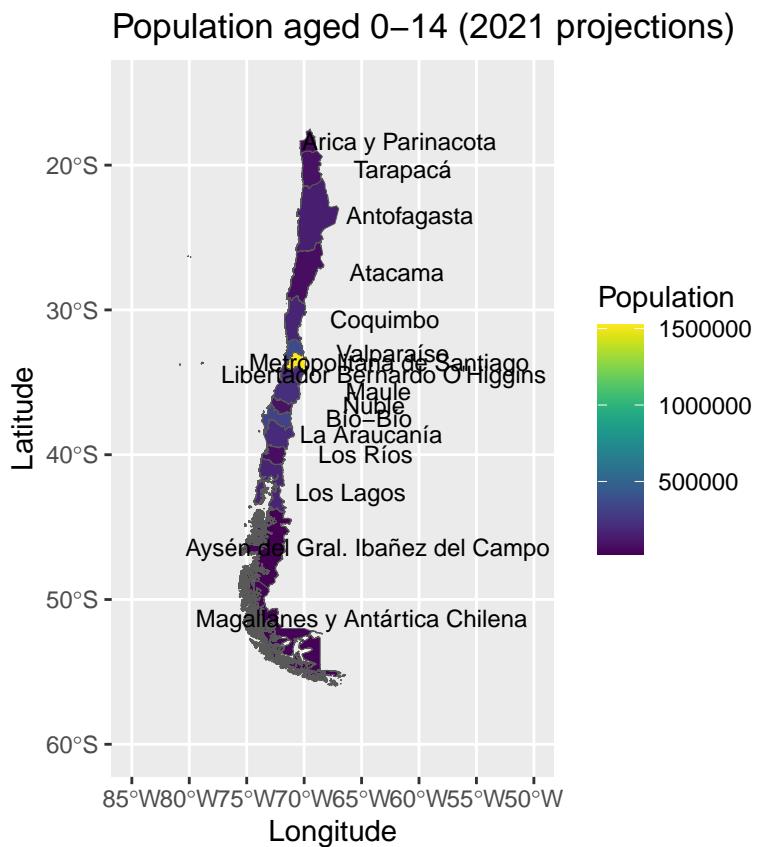


Figure 1: Population of 0-14 year olds in Chile in 2021 by region, from 2017 census projections.

# 4 Methods

# 5 Results

## 5.1 School data

TODO - table summarising data content

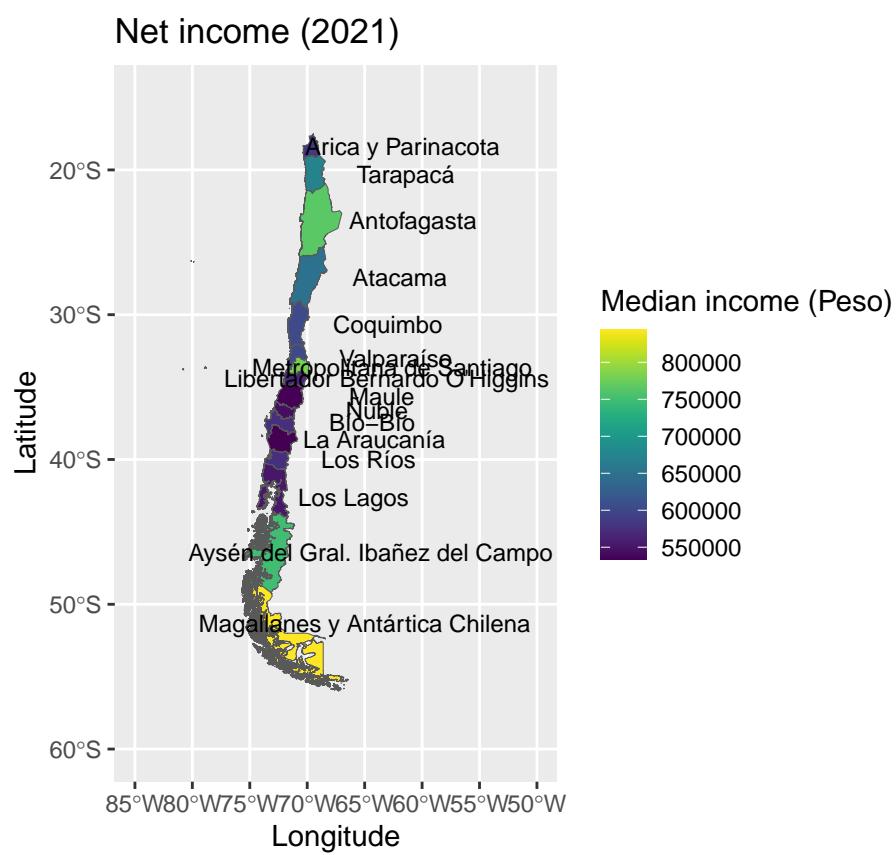


Figure 2: Net income from main job in Chile in 2021 by region, from the INE's Supplementary Income Survey.

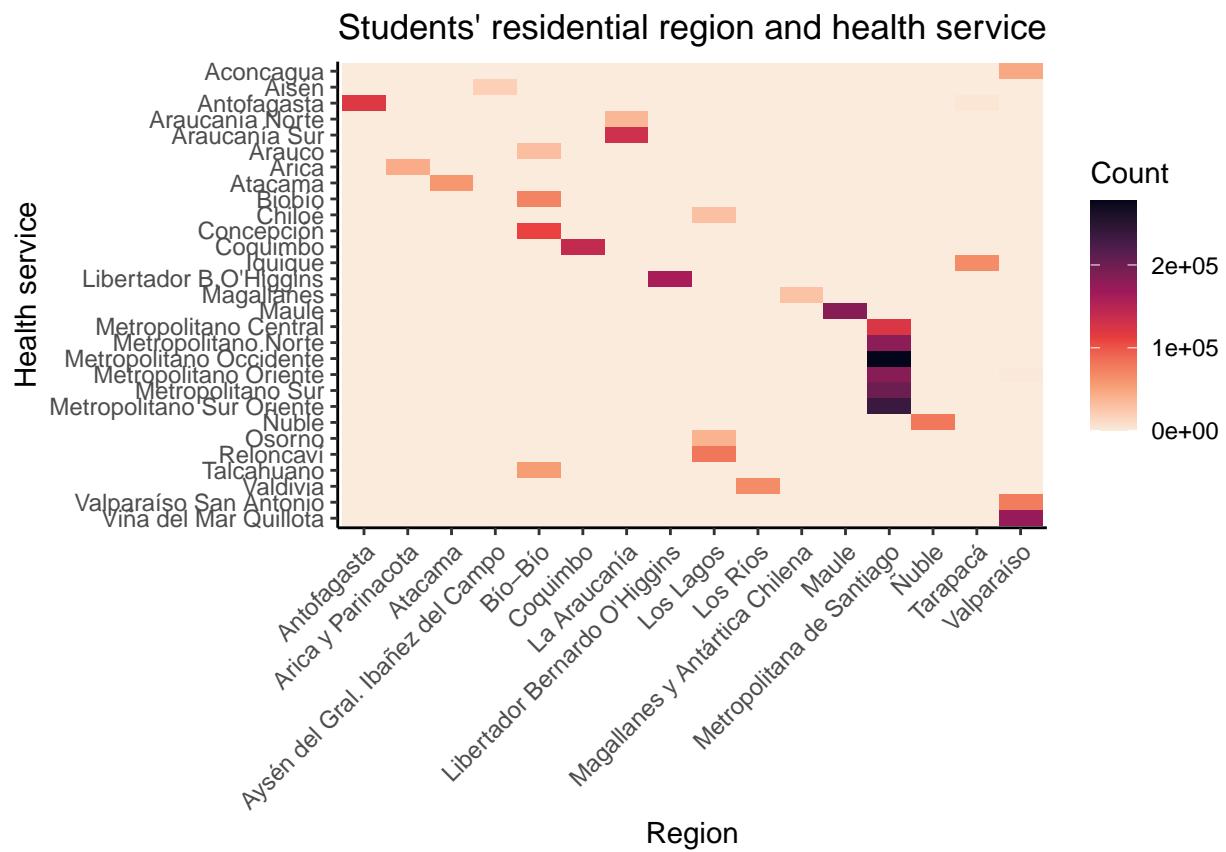


Figure 3: Residential communes aggregated to region level and the health services associated with the aggregated communes, with counts of the number of students resident in the communes in each health service's catchment area.

## Communes in La Araucanía

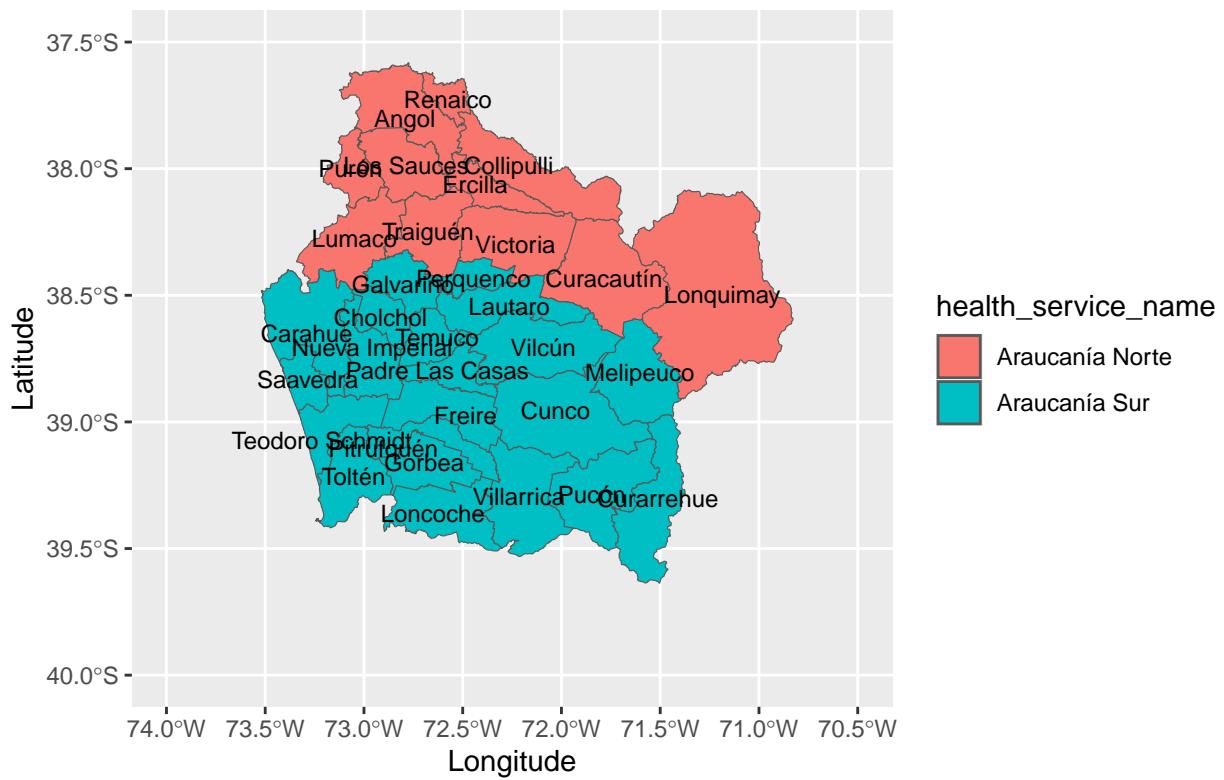


Figure 4: Communes in the Araucanía region, coloured red for the Araucanía Norte (north Araucanía) health services and blue for the Araucanía Sur (south Araucanía) health service.

In the school data, 4078 (0.13%) students were missing commune of residence. These missing values were imputed with their school's commune as most students are likely to go to school near their place of residence.

## 5.2 Frequentist prevalence estimation

### 5.2.1 Autism and ADHD prevalence by sex

```
## # A tibble: 1 x 6
##   crude_ci_lower crude_rate crude_ci_upper adjusted_ci_lower adjusted_~1 adjus~2
##       <dbl>        <dbl>        <dbl>        <dbl>        <dbl>      <dbl>
## 1     0.00468     0.00476     0.00484     0.00457     0.00465 0.00473
## # ... with abbreviated variable names 1: adjusted_rate, 2: adjusted_ci_upper

## # A tibble: 1 x 6
##   crude_ci_lower crude_rate crude_ci_upper adjusted_ci_lower adjusted_~1 adjus~2
##       <dbl>        <dbl>        <dbl>        <dbl>        <dbl>      <dbl>
## 1     0.0150      0.0151      0.0153      0.0148      0.0150  0.0151
## # ... with abbreviated variable names 1: adjusted_rate, 2: adjusted_ci_upper

## # A tibble: 2 x 7
##   sex_desc crude_ci_lower crude_rate crude_ci_upper adjusted_c~1 adjus~2 adjus~3
##   <chr>        <dbl>        <dbl>        <dbl>        <dbl>      <dbl>      <dbl>
## 1 Male         0.00787     0.00801     0.00815     0.00773 0.00787 0.00801
## 2 Female       0.00127     0.00133     0.00139     0.00125 0.00131 0.00138
## # ... with abbreviated variable names 1: adjusted_ci_lower, 2: adjusted_rate,
## #   3: adjusted_ci_upper

## # A tibble: 2 x 7
##   sex_desc crude_ci_lower crude_rate crude_ci_upper adjusted_c~1 adjus~2 adjus~3
##   <chr>        <dbl>        <dbl>        <dbl>        <dbl>      <dbl>      <dbl>
## 1 Male         0.0196      0.0198      0.0201      0.0194  0.0197  0.0199
## 2 Female       0.00998    0.0101      0.0103      0.00997 0.0101  0.0103
## # ... with abbreviated variable names 1: adjusted_ci_lower, 2: adjusted_rate,
## #   3: adjusted_ci_upper
```

### 5.2.2 Autism and ADHD prevalence by health service

	health_service_name	crude_ci_lower	crude_rate	crude_ci_upper
## 1	Aconcagua	0.00378	0.00438	0.00497
## 2	Aisén	0.00629	0.00749	0.00869
## 3	Antofagasta	0.00791	0.00842	0.00893
## 4	Araucanía Norte	0.00244	0.00300	0.00356
## 5	Araucanía Sur	0.00336	0.00369	0.00402
## 6	Arauco	0.00637	0.00731	0.00826
## 7	Arica	0.00540	0.00612	0.00684
## 8	Atacama	0.00262	0.00306	0.00351
## 9	Biobío	0.00383	0.00431	0.00479
## 10	Chiloé	0.00375	0.00450	0.00524
## 11	Concepción	0.00732	0.00784	0.00837
## 12	Coquimbo	0.00378	0.00412	0.00445
## 13	Libertador B.O'Higgins	0.00402	0.00434	0.00467
## 14	Maule	0.00280	0.00305	0.00331
## 15	Reloncaví	0.00379	0.00424	0.00469
## 16	Iquique	0.00381	0.00431	0.00481
## 17	Magallanes	0.00725	0.00831	0.00938
## 18	Metropolitano Central	0.00385	0.00421	0.00457

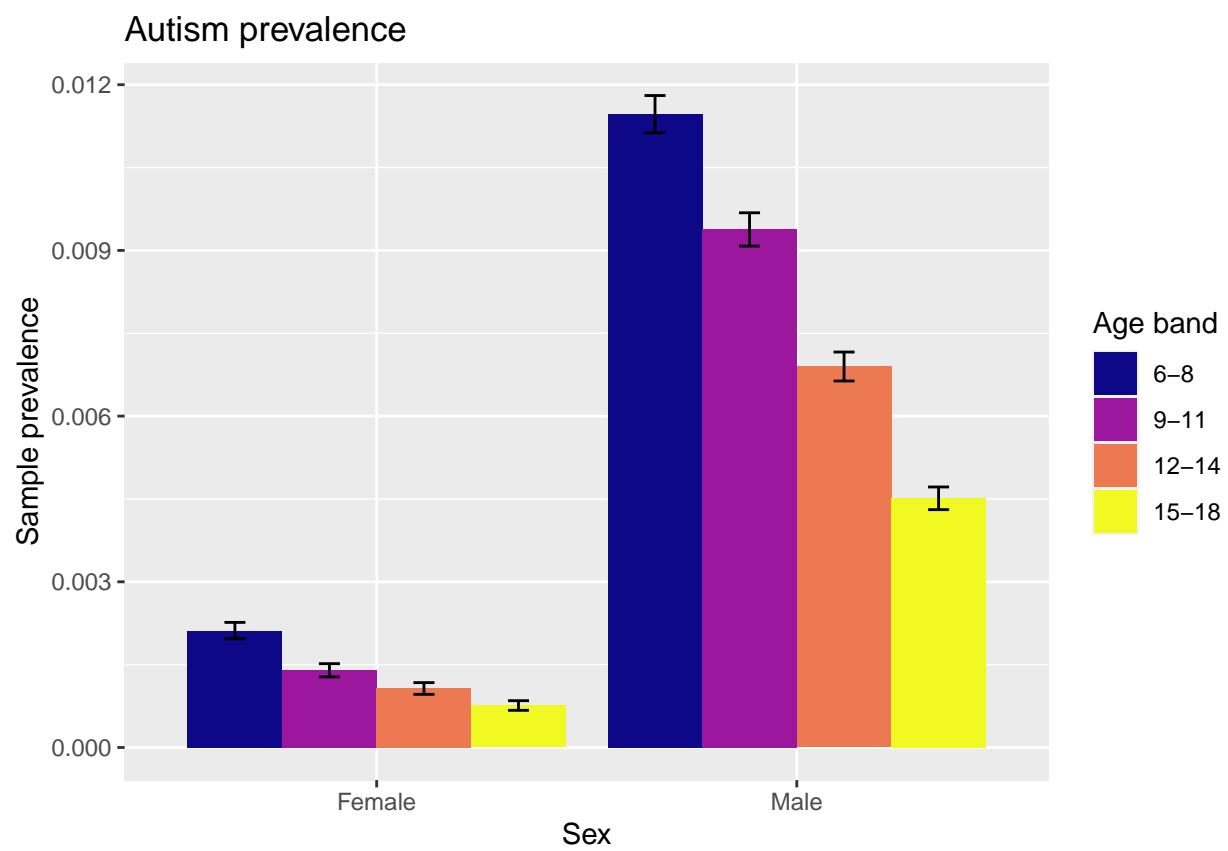


Figure 5: Sample prevalence of autism by age band and sex. Bars show 95% normal confidence intervals.

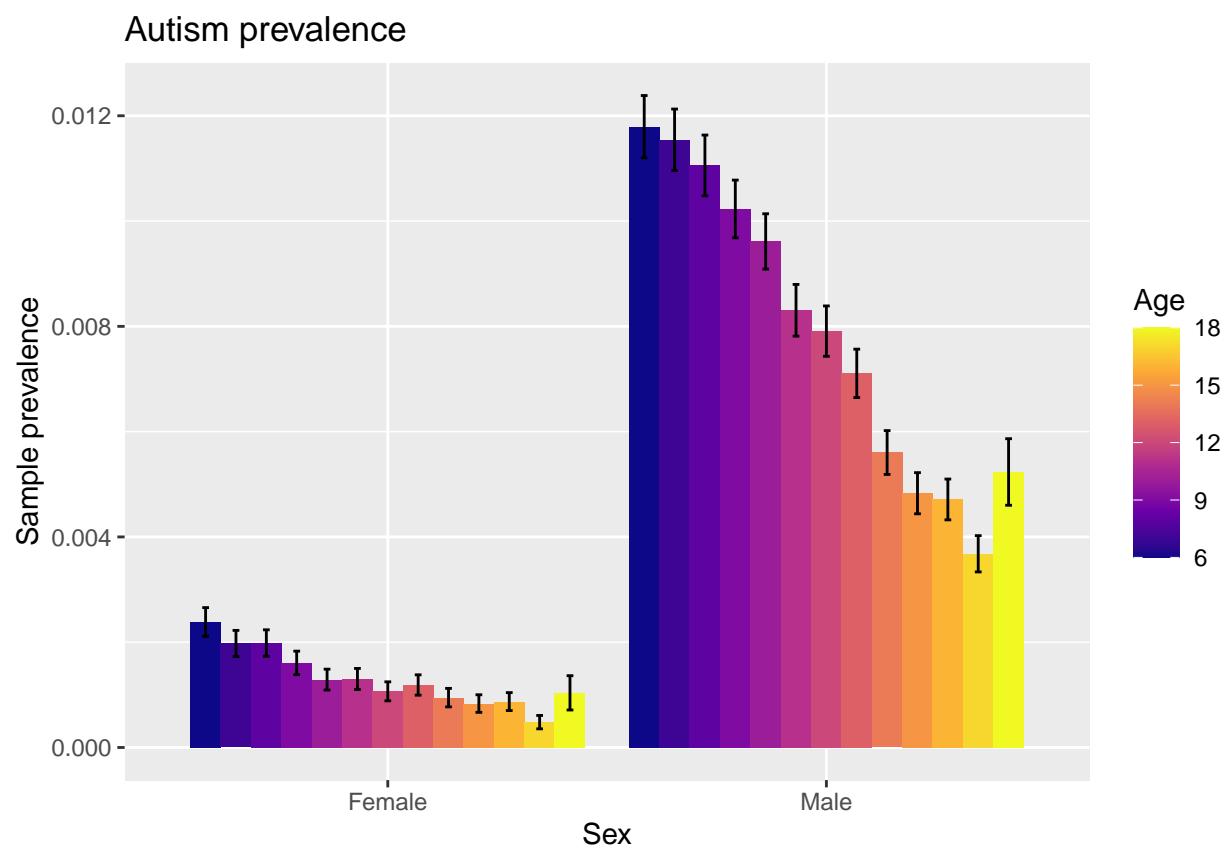


Figure 6: Sample prevalence of autism by age and sex. Bars show 95% normal confidence intervals.

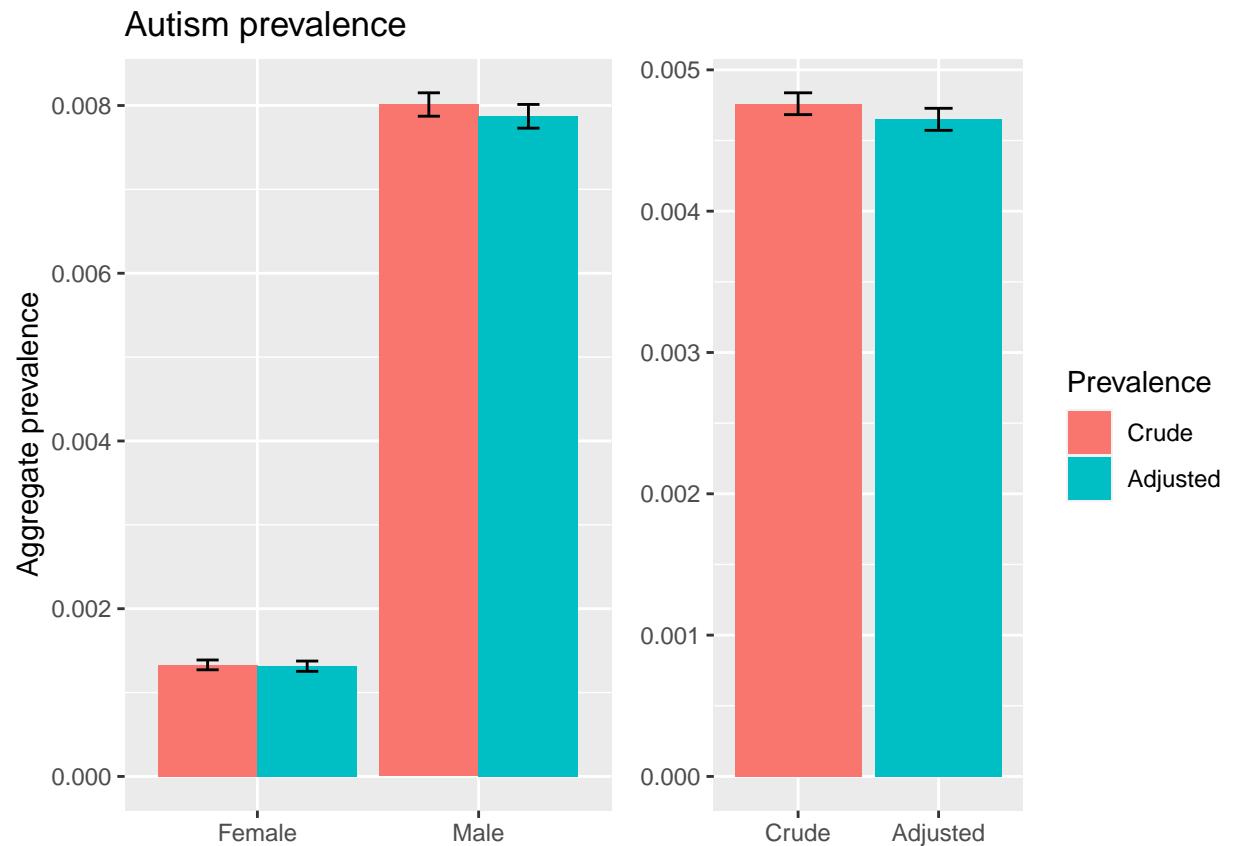


Figure 7: Crude and age- and sex-adjusted sample prevalences of autism, by sex and in aggregate. Bars for crude prevalence show 95% normal confidence intervals and bars for adjusted prevalence show 95% gamma confidence intervals.

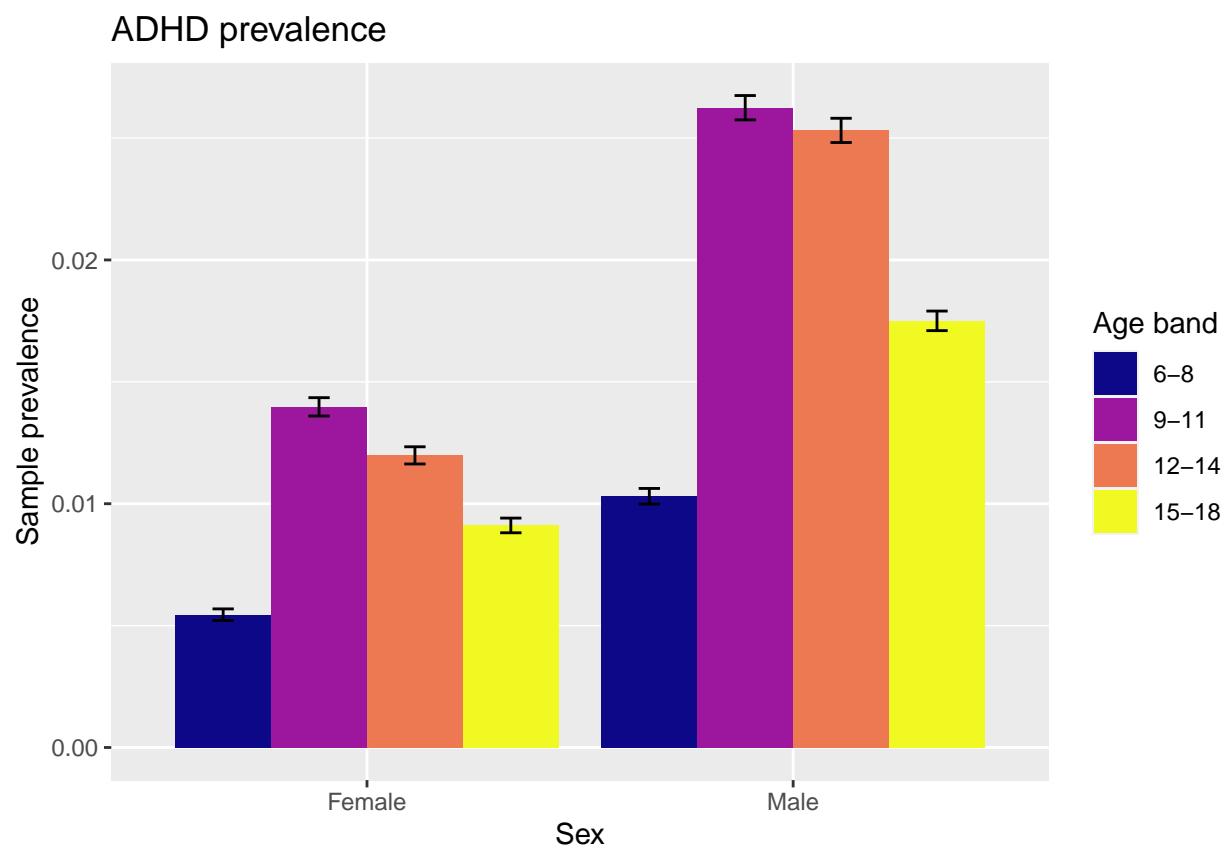


Figure 8: Sample prevalence of ADHD by age band and sex. Bars show 95% normal confidence intervals.

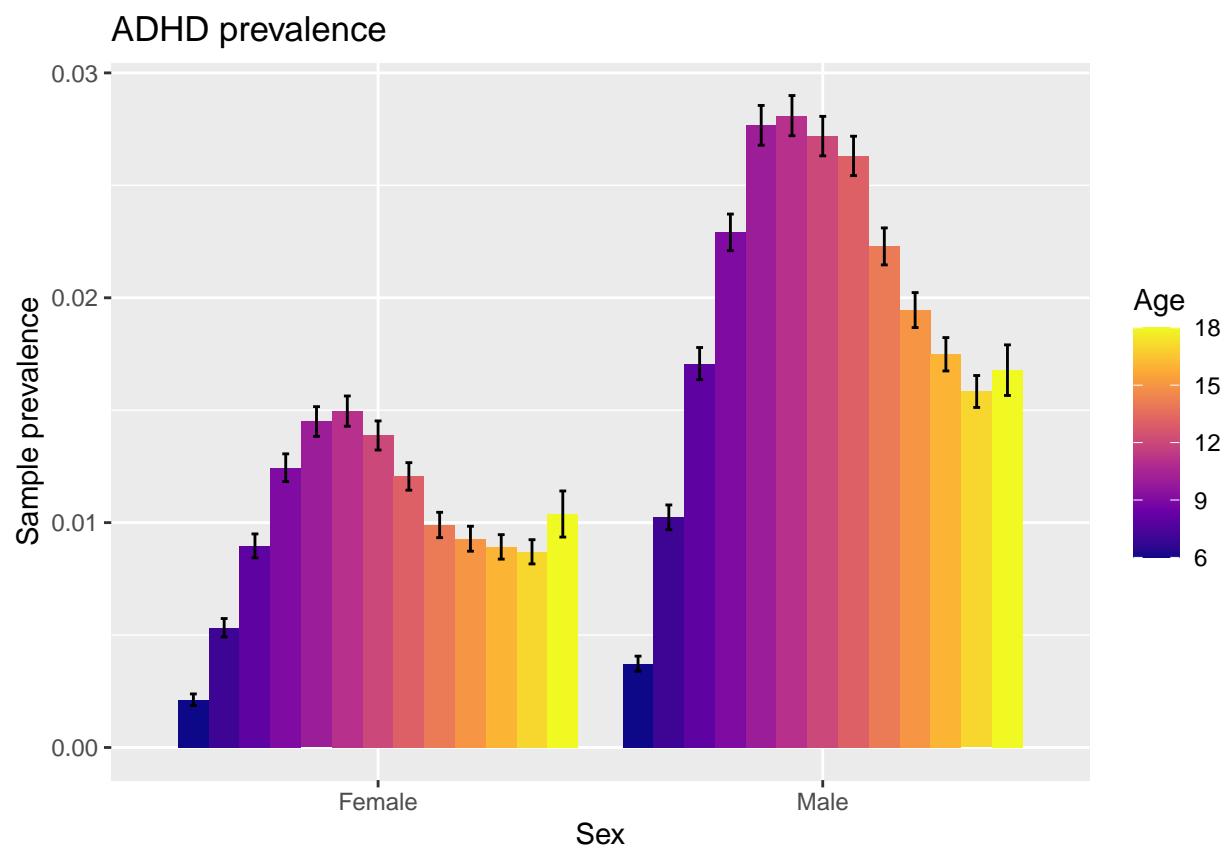


Figure 9: Sample prevalence of ADHD by age and sex. Bars show 95% normal confidence intervals.

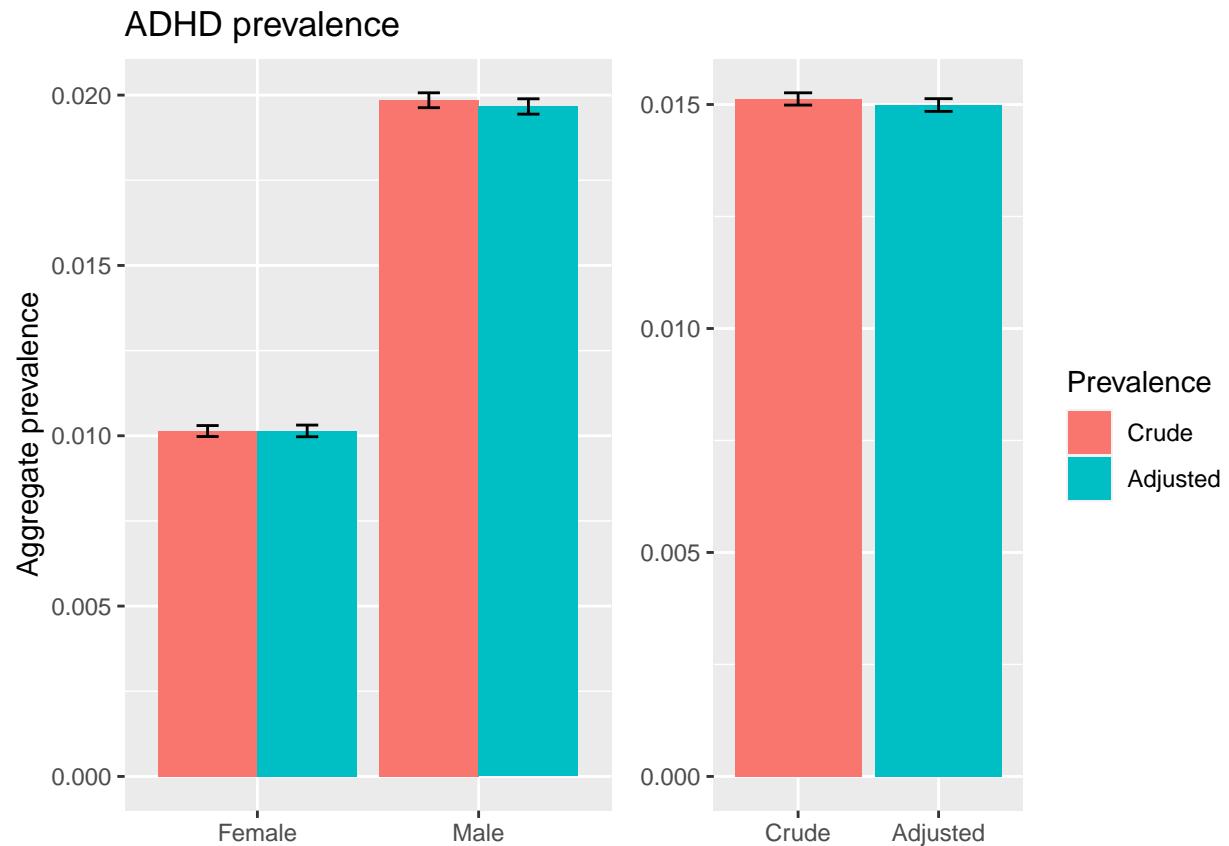


Figure 10: Crude and age- and sex-adjusted sample prevalences of ADHD, by sex and in aggregate. Bars for crude prevalence show 95% normal confidence intervals and bars for adjusted prevalence show 95% gamma confidence intervals.

	Metropolitano Norte	0.00269	0.00294	0.00318
## 20	Metropolitano Occidente	0.00336	0.00358	0.00381
## 21	Metropolitano Oriente	0.00279	0.00304	0.00329
## 22	Metropolitano Sur	0.00385	0.00413	0.00442
## 23	Metropolitano Sur Oriente	0.00342	0.00367	0.00391
## 24	Osorno	0.00380	0.00445	0.00510
## 25	Talcahuano	0.00763	0.00839	0.00916
## 26	Valdivia	0.00269	0.00311	0.00354
## 27	Valparaíso San Antonio	0.00635	0.00694	0.00752
## 28	Viña del Mar Quillota	0.00632	0.00670	0.00709
## 29	Ñuble	0.01238	0.01317	0.01396
	adjusted_ci_lower adjusted_rate adjusted_ci_upper			
## 1	0.00369	0.00427	0.00499	
## 2	0.00634	0.00752	0.00895	
## 3	0.00774	0.00825	0.00881	
## 4	0.00245	0.00300	0.00376	
## 5	0.00338	0.00372	0.00410	
## 6	0.00624	0.00715	0.00825	
## 7	0.00539	0.00614	0.00704	
## 8	0.00266	0.00312	0.00368	
## 9	0.00373	0.00420	0.00475	
## 10	0.00364	0.00433	0.00518	
## 11	0.00718	0.00771	0.00828	
## 12	0.00364	0.00396	0.00433	
## 13	0.00393	0.00425	0.00460	
## 14	0.00277	0.00303	0.00332	
## 15	0.00373	0.00417	0.00467	
## 16	0.00363	0.00410	0.00466	
## 17	0.00724	0.00831	0.00958	
## 18	0.00380	0.00416	0.00456	
## 19	0.00262	0.00287	0.00314	
## 20	0.00316	0.00338	0.00361	
## 21	0.00274	0.00298	0.00325	
## 22	0.00371	0.00398	0.00427	
## 23	0.00339	0.00364	0.00390	
## 24	0.00371	0.00433	0.00507	
## 25	0.00739	0.00813	0.00898	
## 26	0.00260	0.00300	0.00349	
## 27	0.00625	0.00683	0.00749	
## 28	0.00620	0.00658	0.00699	
## 29	0.01208	0.01286	0.01371	
	health_service_name crude_ci_lower crude_rate crude_ci_upper			
## 1	Aconcagua	0.01950	0.02079	0.02209
## 2	Aisén	0.02027	0.02232	0.02438
## 3	Antofagasta	0.00958	0.01014	0.01071
## 4	Araucanía Norte	0.01217	0.01334	0.01452
## 5	Araucanía Sur	0.01358	0.01422	0.01485
## 6	Arauco	0.01501	0.01641	0.01782
## 7	Arica	0.01040	0.01139	0.01237
## 8	Atacama	0.00435	0.00492	0.00549
## 9	Biobío	0.02159	0.02269	0.02378
## 10	Chiloé	0.02771	0.02960	0.03149
## 11	Concepción	0.02842	0.02942	0.03043

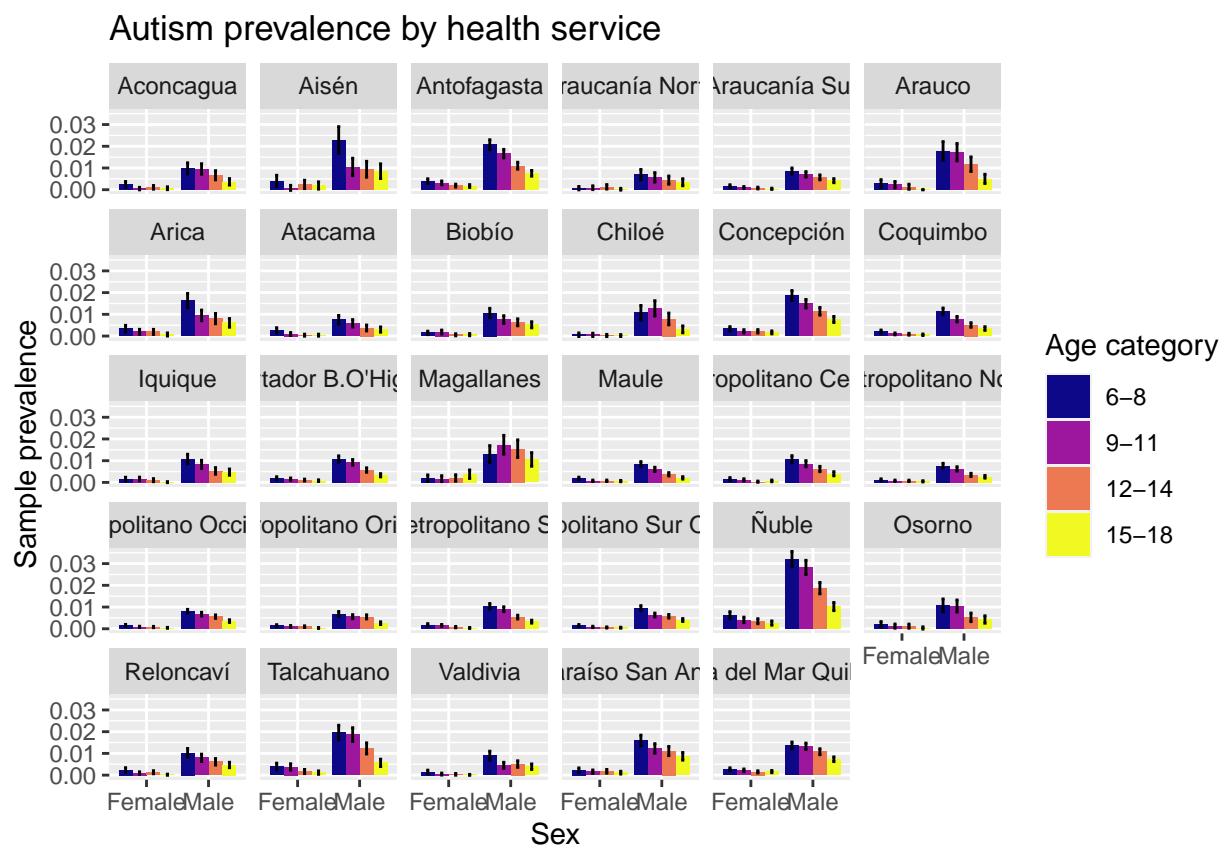


Figure 11: Sample prevalence of autism by health service, age band and sex. Bars show 95% normal confidence intervals.

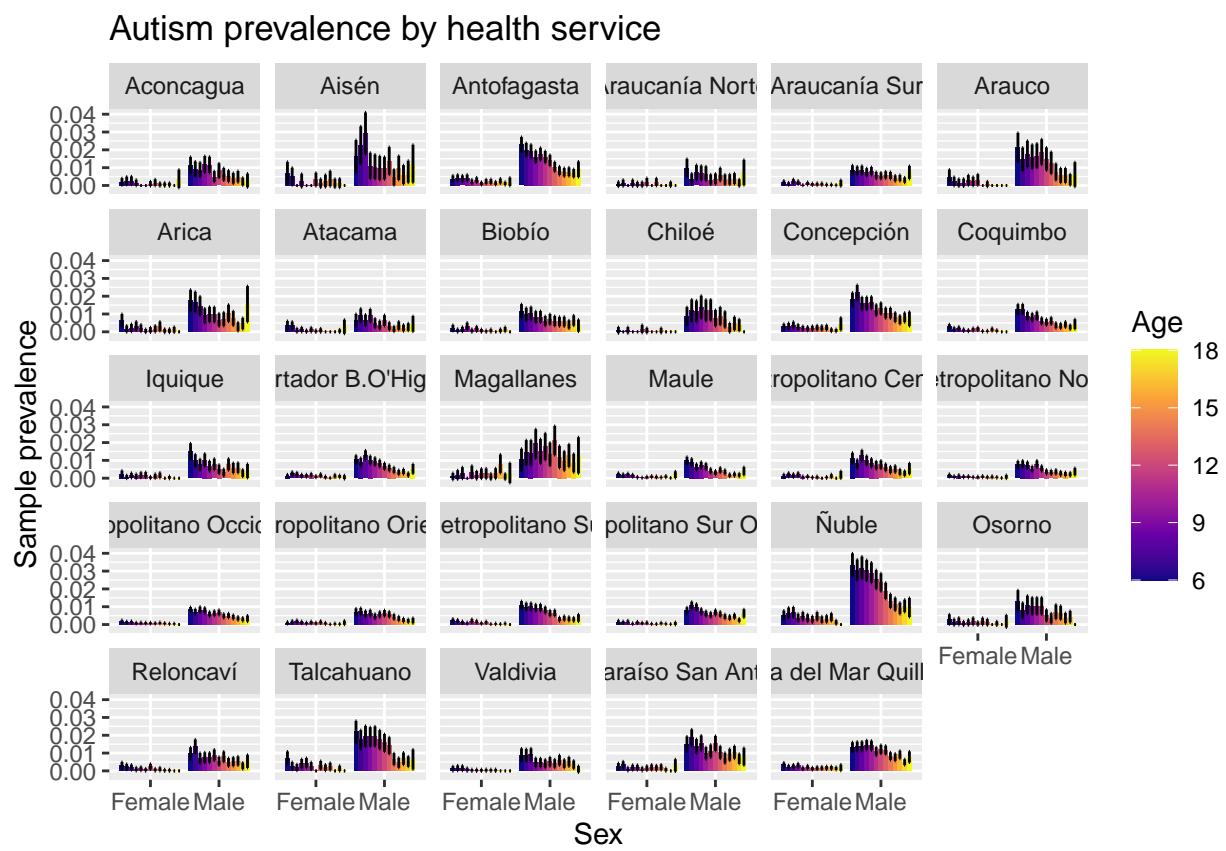


Figure 12: Sample prevalence of autism by health service, age and sex. Bars show 95% normal confidence intervals.

### Autism prevalence by health service



Figure 13: Crude and age- and sex-adjusted sample prevalences of autism by health service. Bars for crude prevalence show 95% normal confidence intervals and bars for adjusted prevalence show 95% gamma confidence intervals.

```

## 12          Coquimbo    0.01907    0.01980    0.02053
## 13 Libertador B.O'Higgins 0.01662    0.01726    0.01789
## 14          Maule      0.01143    0.01193    0.01243
## 15 Reloncaví      0.00952    0.01022    0.01092
## 16          Iquique    0.01402    0.01494    0.01586
## 17 Magallanes      0.02870    0.03072    0.03274
## 18 Metropolitano Central 0.01457    0.01526    0.01594
## 19 Metropolitano Norte   0.01361    0.01416    0.01471
## 20 Metropolitano Occidente 0.01054    0.01093    0.01131
## 21 Metropolitano Oriente  0.01163    0.01213    0.01263
## 22 Metropolitano Sur      0.01372    0.01424    0.01476
## 23 Metropolitano Sur Oriente 0.01512    0.01562    0.01611
## 24          Osorno      0.00946    0.01046    0.01145
## 25 Talcahuano      0.02926    0.03071    0.03215
## 26          Valdivia    0.00998    0.01077    0.01156
## 27 Valparaíso San Antonio 0.01132    0.01209    0.01286
## 28 Viña del Mar Quillota   0.01123    0.01174    0.01224
## 29          Ñuble       0.02019    0.02120    0.02220
## adjusted_ci_lower adjusted_rate adjusted_ci_upper
## 1        0.01913    0.02044    0.02187
## 2        0.01970    0.02171    0.02398
## 3        0.00938    0.00994    0.01056
## 4        0.01179    0.01294    0.01426
## 5        0.01320    0.01384    0.01452
## 6        0.01497    0.01642    0.01806
## 7        0.01022    0.01122    0.01237
## 8        0.00431    0.00488    0.00556
## 9        0.02146    0.02260    0.02382
## 10       0.02680    0.02867    0.03069
## 11       0.02889    0.02998    0.03112
## 12       0.01922    0.02000    0.02082
## 13       0.01626    0.01691    0.01759
## 14       0.01105    0.01154    0.01207
## 15       0.00923    0.00991    0.01065
## 16       0.01405    0.01502    0.01608
## 17       0.02853    0.03064    0.03294
## 18       0.01426    0.01495    0.01568
## 19       0.01361    0.01417    0.01476
## 20       0.01082    0.01123    0.01166
## 21       0.01146    0.01196    0.01248
## 22       0.01354    0.01407    0.01462
## 23       0.01481    0.01531    0.01583
## 24       0.00922    0.01020    0.01129
## 25       0.02872    0.03022    0.03182
## 26       0.00983    0.01062    0.01150
## 27       0.01129    0.01208    0.01294
## 28       0.01097    0.01147    0.01201
## 29       0.02001    0.02105    0.02217

## # A tibble: 21 x 7
##   commune_name crude_ci_lower crude_rate crude_ci_upper adjus~1 adjus~2 adjus~3
##   <chr>           <dbl>      <dbl>           <dbl>      <dbl>      <dbl>      <dbl>
## 1 Carahue        0.00116    0.00266        0.00416  0.00129  0.0025  0.00588
## 2 Cholchol        0           0.00138        0.00295  0.00026  0.00128 0.00816

```

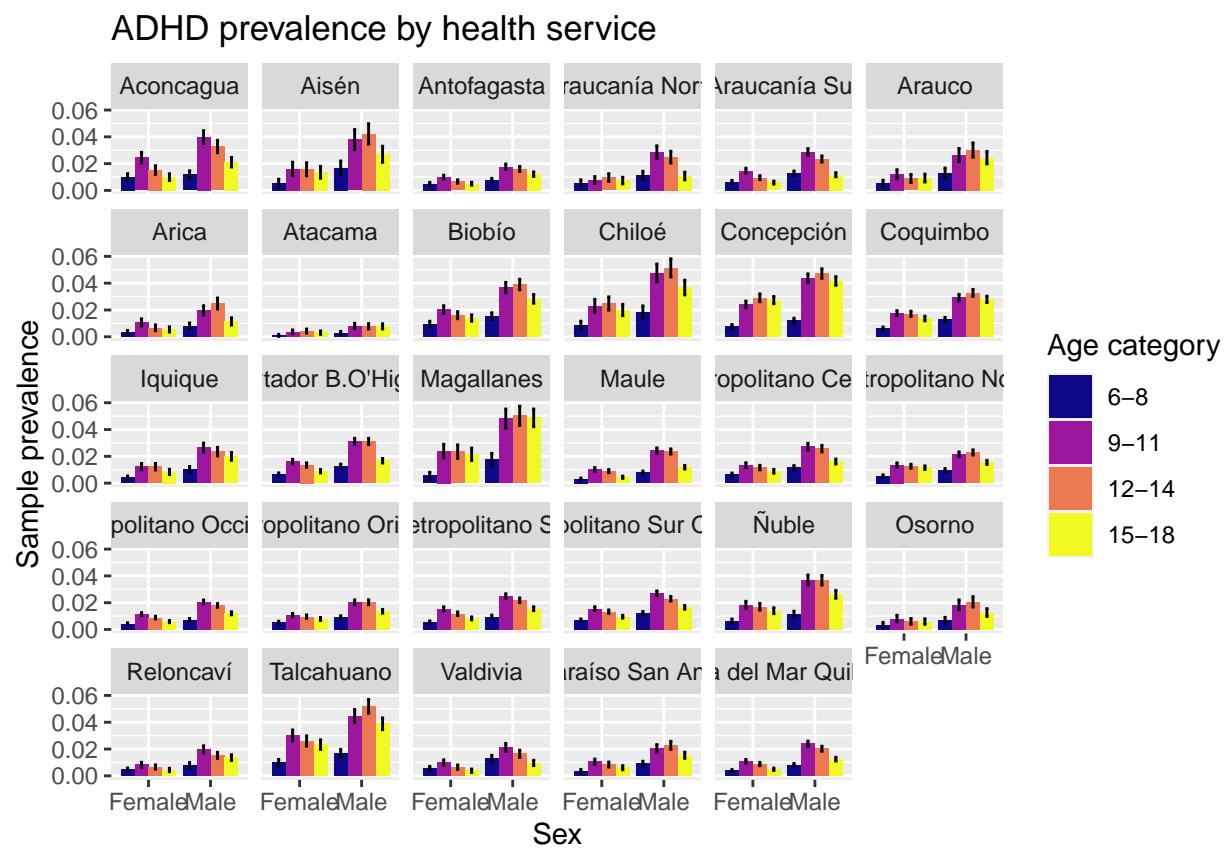


Figure 14: Sample prevalence of ADHD by health service, age band and sex. Bars show 95% normal confidence intervals.

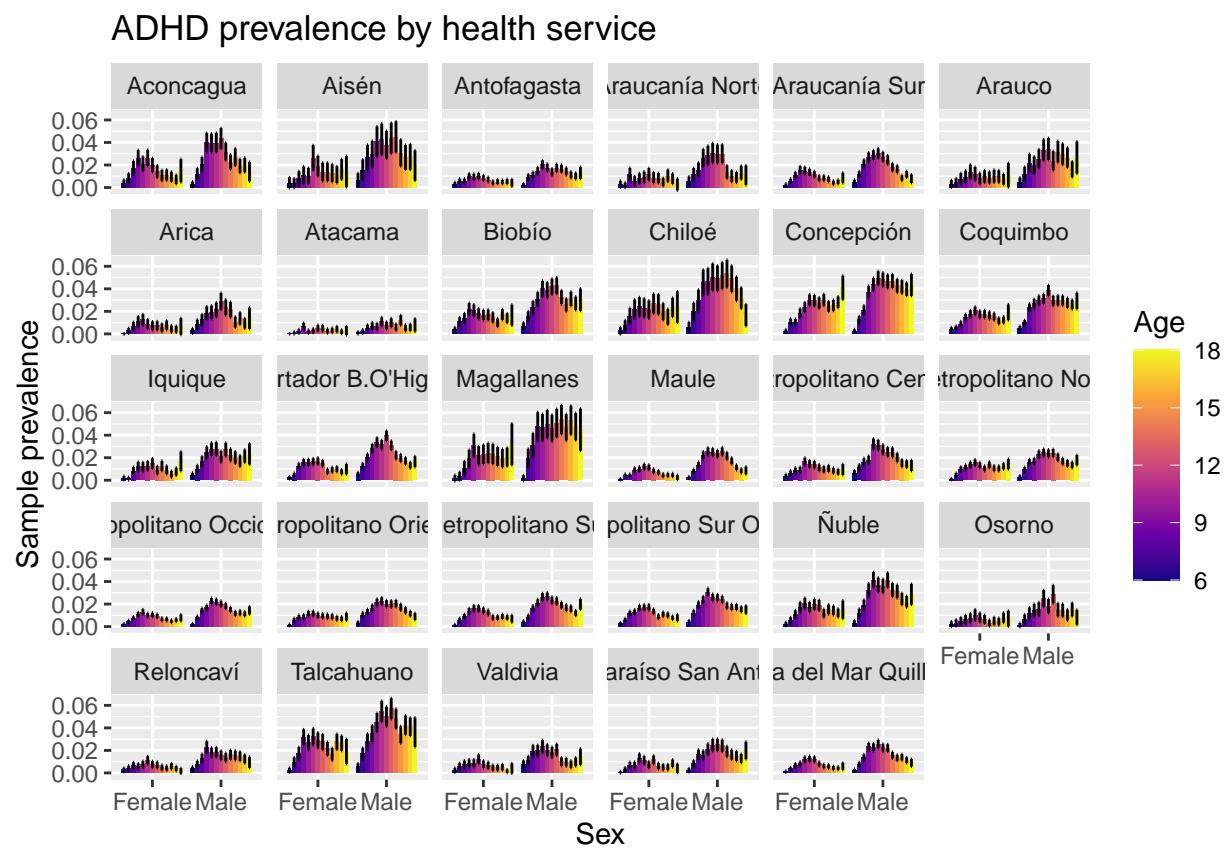


Figure 15: Sample prevalence of ADHD by health service, age and sex. Bars show 95% normal confidence intervals.

### ADHD prevalence by health service



Figure 16: Crude and age- and sex-adjusted sample prevalences of ADHD by health service. Bars for crude prevalence show 95% normal confidence intervals and bars for adjusted prevalence show 95% gamma confidence intervals.

```

## 3 Cunco          0.00229   0.0048    0.00732 0.00258 0.00472 0.0100
## 4 Curarrehue    0         0.00147   0.00351 0.00017 0.00142 0.00804
## 5 Freire         0.00195   0.00381   0.00567 0.0021   0.00369 0.00672
## 6 Galvarino      0.00196   0.00478   0.0076   0.0023   0.00463 0.0101
## 7 Gorbea         0.00235   0.0054    0.00844 0.00258 0.0052   0.0118
## 8 Lautaro        0.00255   0.00401   0.00546 0.00259 0.00387 0.00647
## 9 Loncoche       0.00062   0.00202   0.00341 0.0009   0.00295 0.00845
## 10 Melipeuco     0         0.00187   0.00445 0.00022 0.00183 0.0144
## # ... with 11 more rows, and abbreviated variable names 1: adjusted_ci_lower,
## #   2: adjusted_rate, 3: adjusted_ci_upper

```

### Autism prevalence by commune in Araucanía Sur

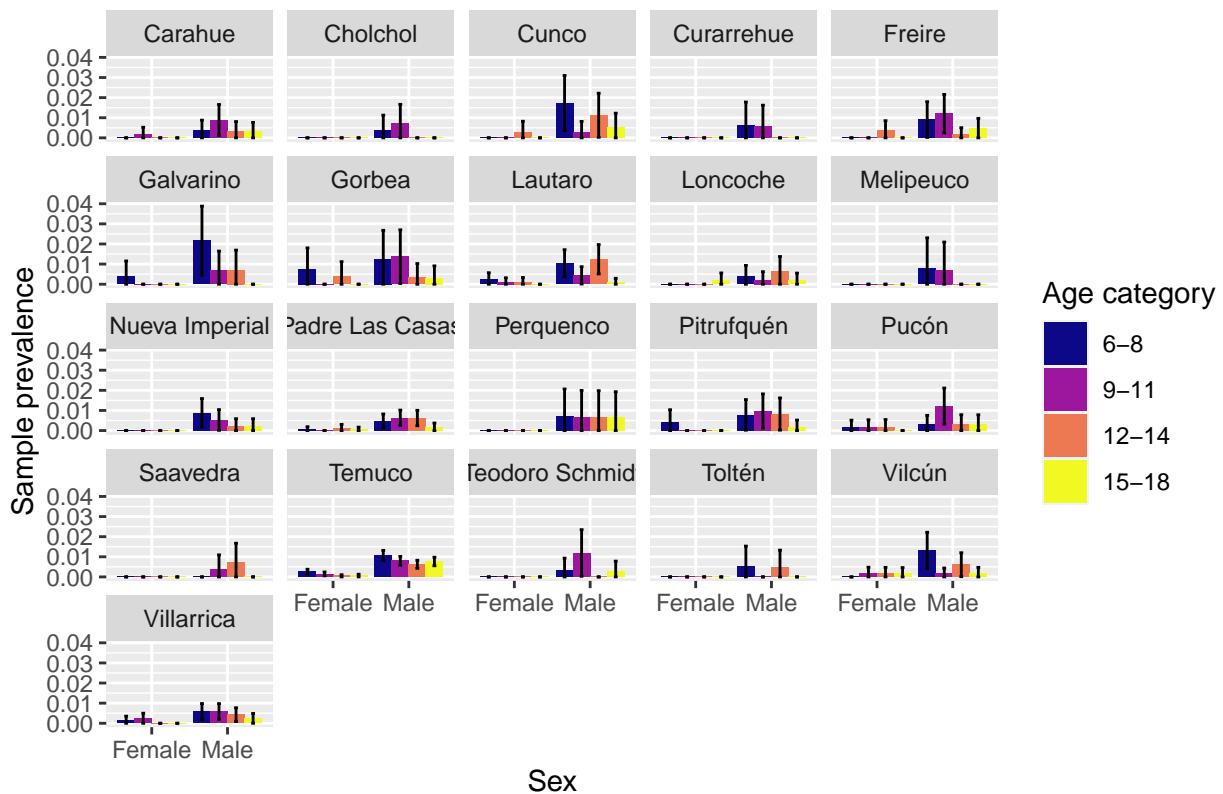


Figure 17: Sample prevalence of autism by commune in Araucanía Sur health service, age band and sex. Bars show 95% normal confidence intervals.

Also do:

- SES status
- Ethnicity
- Rurality

Copy the health service section.

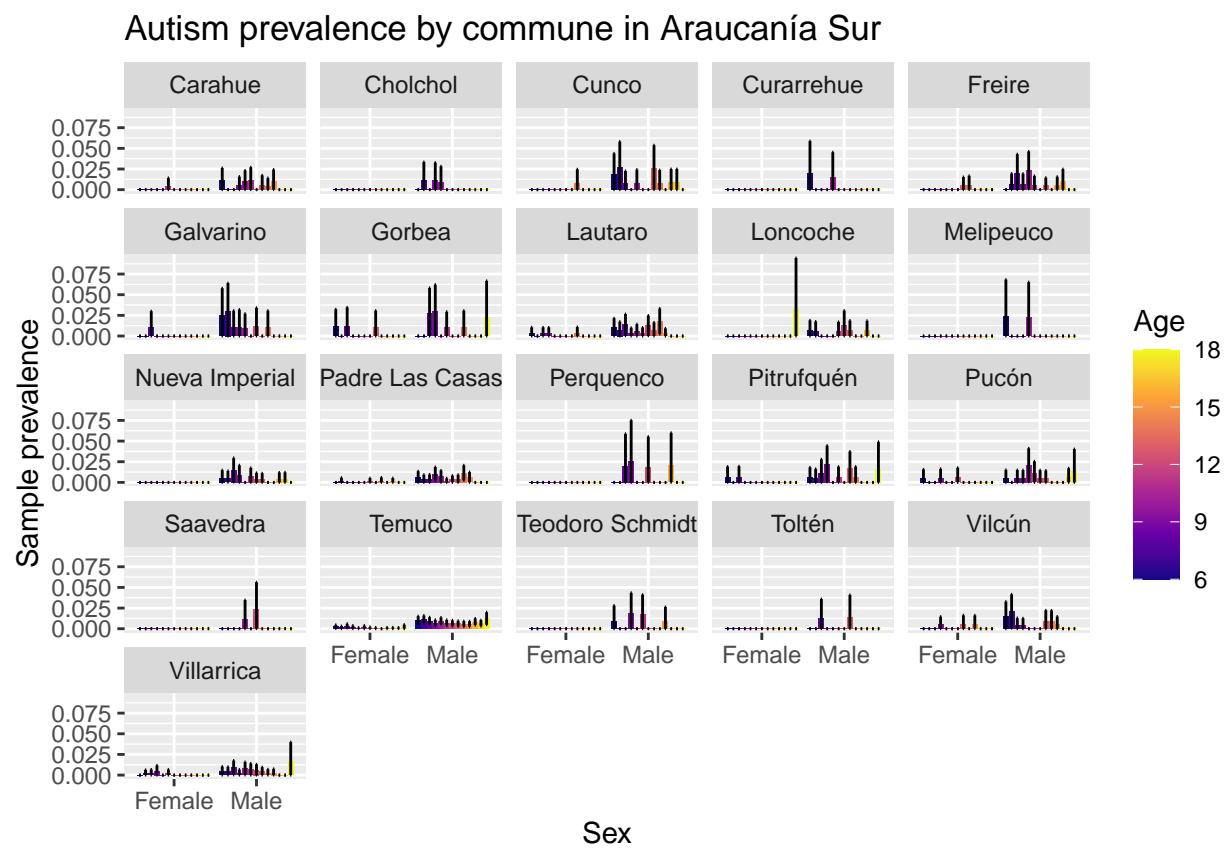


Figure 18: Sample prevalence of autism by commune in Araucanía Sur health service, age and sex. Bars show 95% normal confidence intervals.

### Autism prevalence by commune in Araucanía Sur

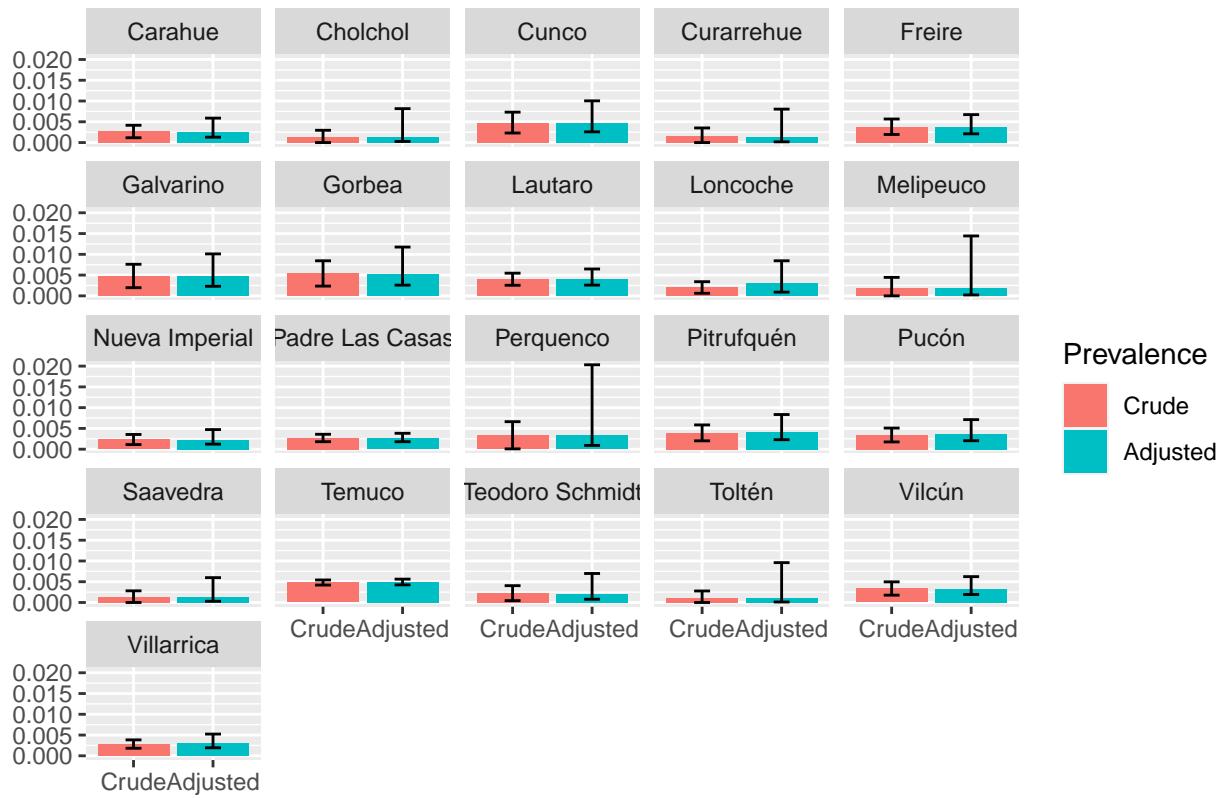


Figure 19: Crude and age- and sex-adjusted sample prevalences of autism by commune in Araucanía Sur health service. Bars for crude prevalence show 95% normal confidence intervals and bars for adjusted prevalence show 95% gamma confidence intervals.

Autism prevalence, prior mean = 0.00465, prior sd = 3.98e-05

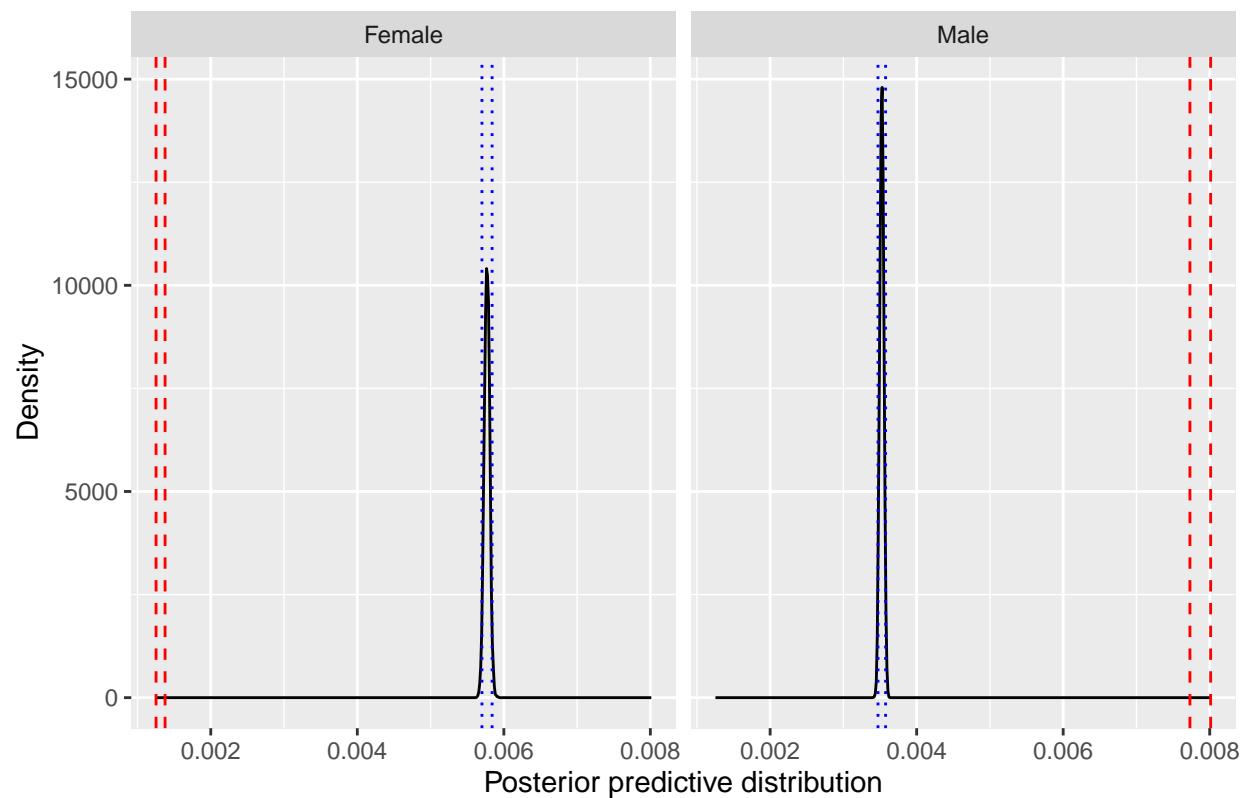


Figure 20: Posterior predictive distribution for autism with a random effect on sex, and with age- and sex-adjusted global prevalence prior.

ADHD prevalence, prior mean = 0.015, prior sd = 7.25e-05

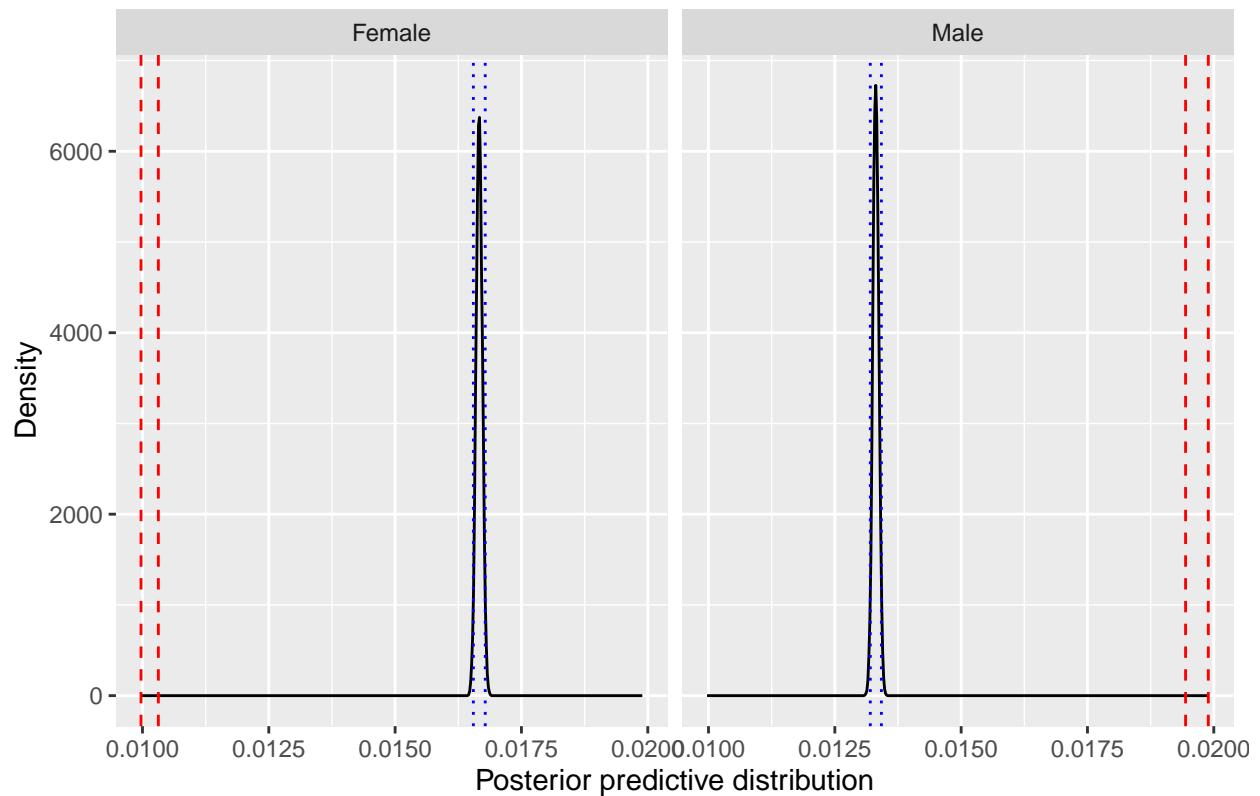


Figure 21: Posterior predictive distribution for ADHD with a random effect on sex, and with age- and sex-adjusted global prevalence prior.

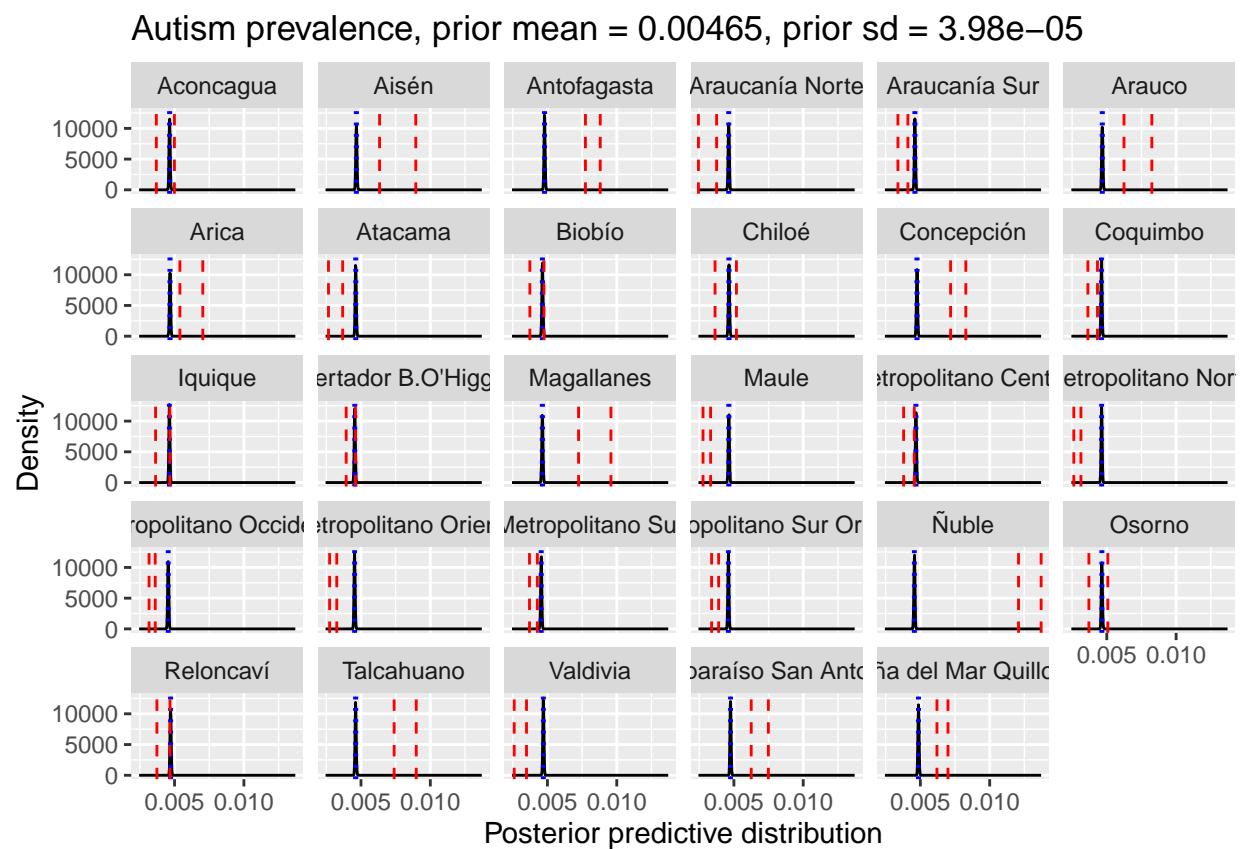


Figure 22: Posterior predictive distribution for autism with a random effect on student's health service, and with age- and sex-adjusted global prevalence prior.

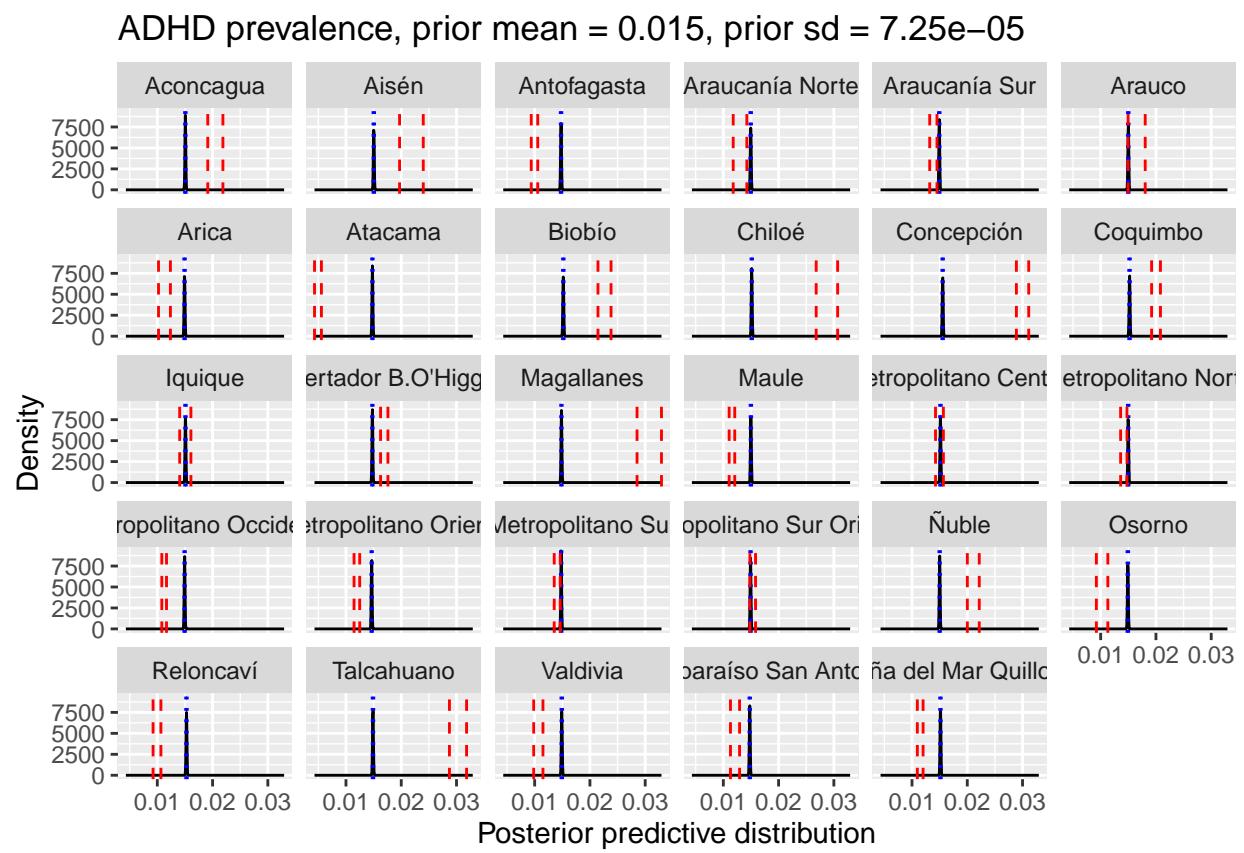


Figure 23: Posterior predictive distribution for ADHD with a random effect on health service, and with age- and sex-adjusted global prevalence prior.

### 5.3 Bayesian prevalence estimation

#### 5.3.1 Random effect on sex

#### 5.3.2 Random effect on health service

#### 5.3.3 Random effect on commune in Araucanía Sur health service

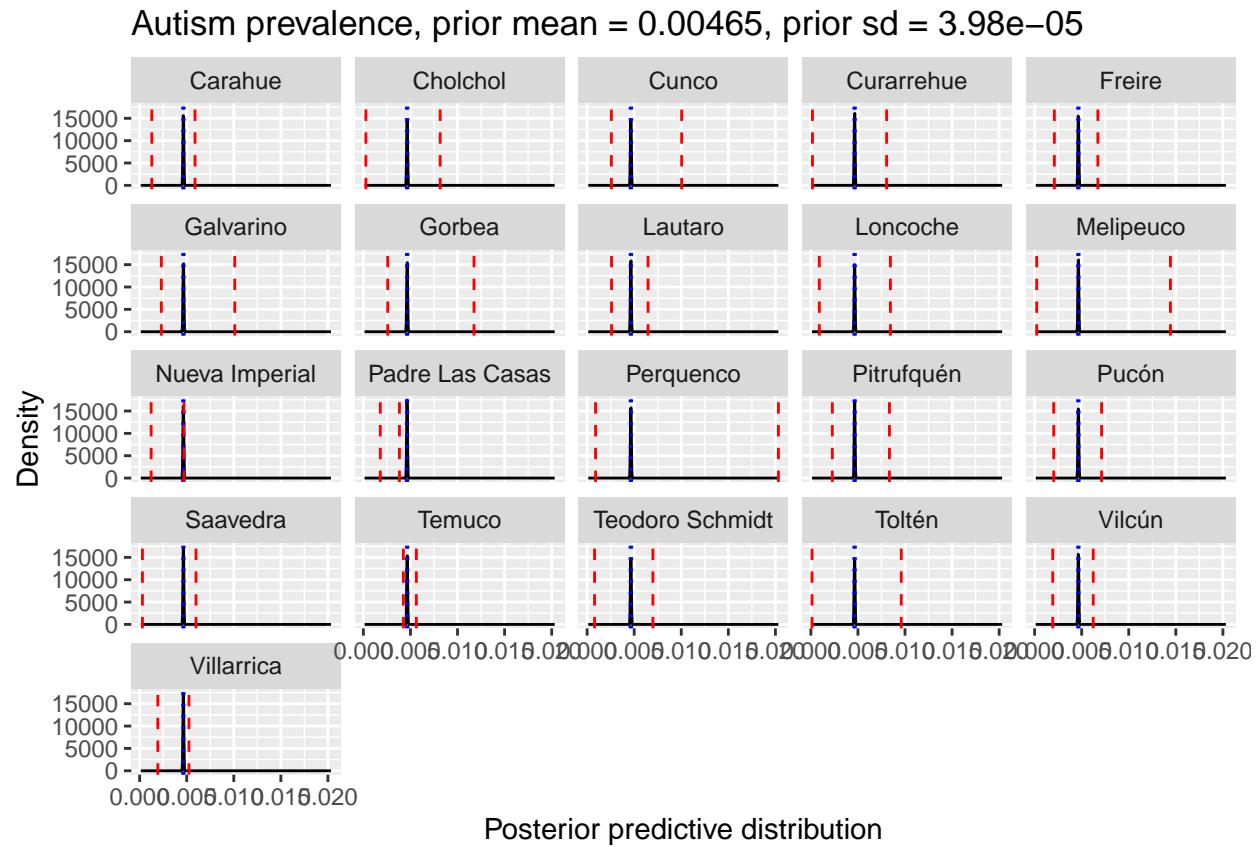


Figure 24: Posterior predictive distribution for autism with a random effect on commune within Araucanía Sur health service, and with age- and sex-adjusted global prevalence prior.

#### 5.3.4 Random effect on socio-economic status

## 6 Supplementary materials

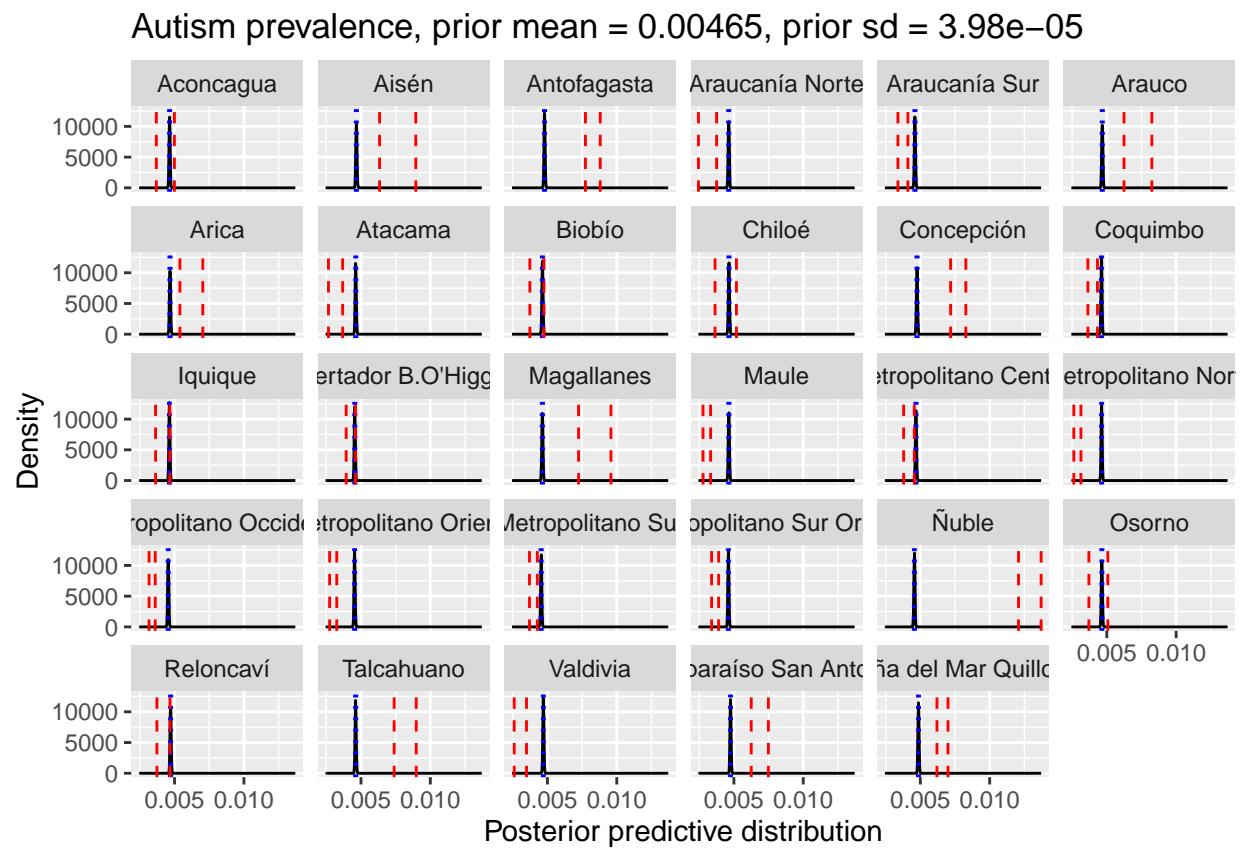


Figure 25: Posterior predictive distribution for autism with a random effect on socio-economic status of student's family, and with age- and sex-adjusted global prevalence prior.

ADHD prevalence, prior mean = 0.015, prior sd = 7.25e-05

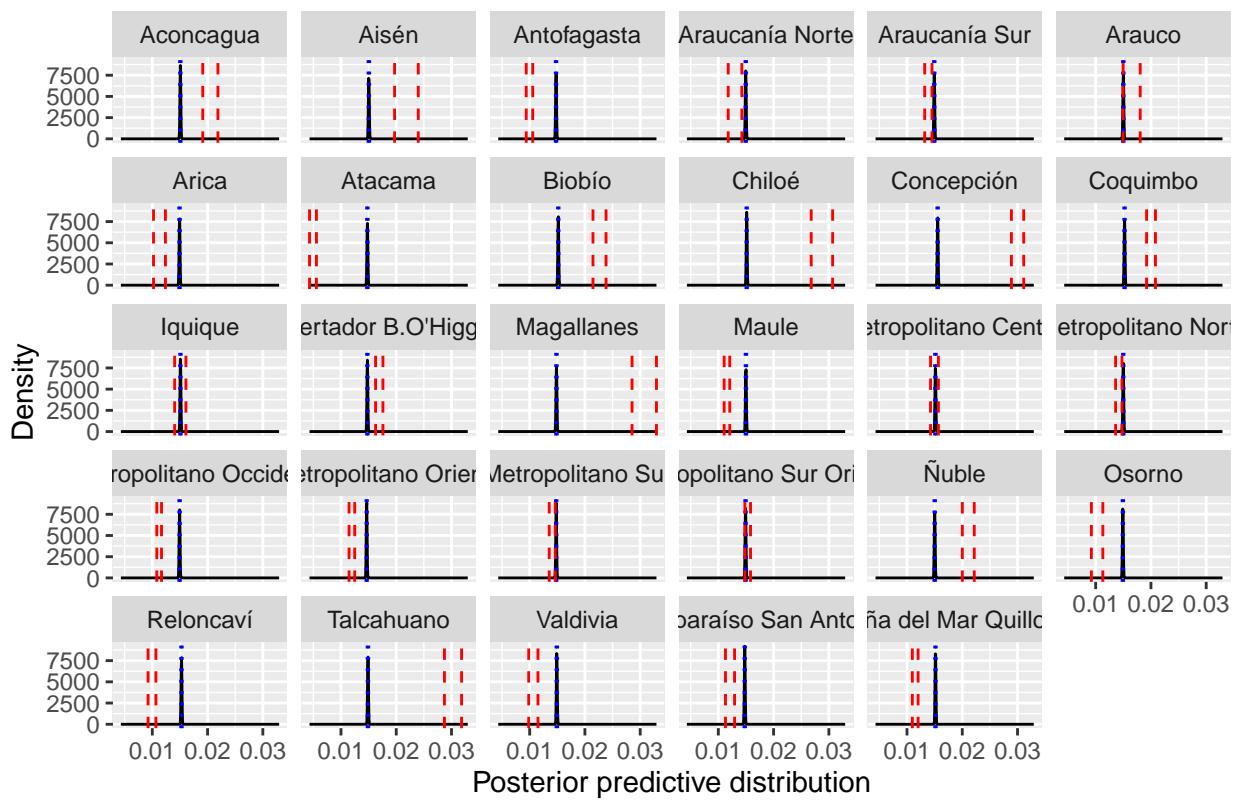


Figure 26: Posterior predictive distribution for ADHD with a random effect on socio-economic status of student's family, and with age- and sex-adjusted global prevalence prior.