**Supplemental Table 1.** Serum creatinine calibration in different NHANES survey periods

|  |  |  |
| --- | --- | --- |
| **Years** | **Serum Creatinine Calibration Equation** | **Reference** |
| **1988-1994** | Standard Creatinine =  0.960\*(measured creatinine) – 0.184 | <http://www.cdc.gov/nchs/data/nhanes/nhanes_03_04/general_%20note_for_serum_creatinine.pdf>\* |
| **1999-2000** | Standard Creatinine =  1.013\*(measured creatinine) + 0.147 | [https://wwwn.cdc.gov/ Nchs/Nhanes/1999-2000/LAB18.htm](https://wwwn.cdc.gov/%20Nchs/Nhanes/1999-2000/LAB18.htm) \* |
| **2001-2002** | None | [https://wwwn.cdc.gov/ Nchs/Nhanes/2001-2002/L40\_B.htm](https://wwwn.cdc.gov/%20Nchs/Nhanes/2001-2002/L40_B.htm)\* |
| **2003-2004** | None | [https://wwwn.cdc.gov/ Nchs/Nhanes/2003-2004/L40\_C.htm](https://wwwn.cdc.gov/%20Nchs/Nhanes/2003-2004/L40_C.htm) \* |
| **2005-2006** | Standard creatinine =  0.978\*(measured creatinine) – 0.016 | http://www.cdc.gov /nchs/nhanes/nhanes2005-2006/BIOPRO\_D.htm |
| **2007-2008** | None | [http://www.cdc.gov/ nchs/data/nhanes/nhanes\_07\_08/CRE\_biopro\_E\_met\_DXC800.pdf](http://www.cdc.gov/%20nchs/data/nhanes/nhanes_07_08/CRE_biopro_E_met_DXC800.pdf) |
| **2009-2010** | None | [http://www.cdc.gov/ NCHS/data/nhanes/nhanes\_09\_10/BIOPRO\_F\_met\_creatinine.pdf](http://www.cdc.gov/%20NCHS/data/nhanes/nhanes_09_10/BIOPRO_F_met_creatinine.pdf) |
| **2011-2012** | None | [http://www.cdc.gov/ nchs/data/nhanes/nhanes\_11\_12/BIOPRO\_G\_met\_creatinine.pdf](http://www.cdc.gov/%20nchs/data/nhanes/nhanes_11_12/BIOPRO_G_met_creatinine.pdf) |

\* see also Selvin E, Manzi J, Stevens LA, Van Lente F, Lacher DA, Levey AS, Coresh J: Calibration of serum creatinine in the National Health and Nutrition Examination Surveys (NHANES) 1988-1994, 1999-2004. Am J Kidney Dis 2007; 50 (6) 918-926.

**Supplemental Table 2. Sampled number of NHANES participants with CKD stages 3-4 (eGFR 15-59 ml/min/1.73m2 by CKD-EPI equation) in U.S. adults by demographic and diabetic categories, NHANES 1988-1994 through 2011-2012**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Years** | | | | | | | | |
|  | **1988-1994** | **1999-2000** | **2001-2002** | **2003-2004** | **2005-2006** | **2007-2008** | **2009-2010** | **2011-2012** |
| **Total** | 1089 | 351 | 436 | 483 | 401 | 477 | 488 | 404 |
| **Age** |  |  |  |  |  |  |  |  |
| 20-39 years | 9 | 5 | 4 | 2 | 3 | 3 | 2 | 5 |
| 40-64 years | 115 | 35 | 59 | 54 | 59 | 78 | 78 | 78 |
| 65-79 years | 491 | 160 | 180 | 203 | 167 | 238 | 223 | 178 |
| ≥80 years | 474 | 151 | 193 | 224 | 172 | 158 | 185 | 143 |
| **Sex** |  |  |  |  |  |  |  |  |
| Male | 517 | 164 | 210 | 215 | 205 | 209 | 231 | 194 |
| Female | 572 | 187 | 226 | 268 | 196 | 268 | 257 | 210 |
| **Race/ethnicity** |  |  |  |  |  |  |  |  |
| Non-Hispanic white | 762 | 210 | 323 | 339 | 290 | 315 | 318 | 210 |
| Non-Hispanic black | 202 | 72 | 64 | 58 | 74 | 84 | 85 | 107 |
| Other race/ethnicity | 125 | 69 | 49 | 86 | 37 | 78 | 85 | 87 |
| **Diabetes status** |  |  |  |  |  |  |  |  |
| With diabetes mellitus | 278 | 92 | 104 | 140 | 121 | 159 | 186 | 162 |
| Without diabetes mellitus | 811 | 259 | 332 | 343 | 280 | 318 | 302 | 242 |

CKD=chronic kidney disease

CKD-EPI = Chronic Kidney Disease-Epidemiology Collaboration

eGFR = estimated glomerular filtration rate

NHANES = National Health and Nutritional Examination Survey

**Supplemental Table 3. Sampled number of NHANES participants with (by CKD-EPI equation) with expanded definition which includes albuminuria ≥30 mg/g regardless of eGFR level in U.S. adults by demographic and diabetic categories, NHANES 1988-1994 through 2011-2012**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Years** | | | | | | | | |
|  | **1988-1994** | **1999-2000** | **2001-2002** | **2003-2004** | **2005-2006** | **2007-2008** | **2009-2010** | **2011-2012** |
| **Total** | 2517 | 748 | 866 | 867 | 799 | 1015 | 936 | 861 |
| **Age** |  |  |  |  |  |  |  |  |
| 20-39 years | 367 | 89 | 104 | 76 | 112 | 105 | 102 | 113 |
| 40-64 years | 658 | 192 | 238 | 203 | 226 | 328 | 272 | 293 |
| 65-79 years | 867 | 280 | 286 | 319 | 245 | 374 | 337 | 268 |
| ≥80 years | 625 | 187 | 238 | 269 | 216 | 208 | 225 | 187 |
| **Sex** |  |  |  |  |  |  |  |  |
| Male | 1120 | 345 | 409 | 413 | 384 | 466 | 447 | 419 |
| Female | 1397 | 403 | 457 | 454 | 415 | 549 | 489 | 442 |
| **Race/ethnicity** |  |  |  |  |  |  |  |  |
| Non-Hispanic white | 1264 | 356 | 511 | 508 | 446 | 541 | 495 | 352 |
| Non-Hispanic black | 643 | 155 | 158 | 142 | 182 | 201 | 170 | 250 |
| Other race/ethnicity | 610 | 237 | 197 | 217 | 171 | 273 | 271 | 259 |
| **Diabetes status** |  |  |  |  |  |  |  |  |
| With diabetes mellitus | 725 | 218 | 246 | 265 | 251 | 363 | 348 | 317 |
| Without diabetes mellitus | 1792 | 530 | 620 | 602 | 548 | 652 | 588 | 544 |

**Supplemental Table 4. Prevalence (percentage) of CKD stages 3-4 (eGFR 15-59 ml/min/1.73m2 by MDRD equation) in U.S. adults by demographic and diabetic categories, NHANES 1988-1994 through 2011-2012;** CI is 95% confidence interval of prevalence (as percentage) are shown in parentheses; N represents the population number in 100,000's (number of significant digits varies by number of sampled NHANES participants in each cell)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Years** | | | | | | | | |
|  | **1988-1994** | **1999-2000** | **2001-2002** | **2003-2004** | **2005-2006** | **2007-2008** | **2009-2010** | **2011-2012** |
| **Total Population** | **5.6% (5.1-6.2%)**  **N = 94.44** | **7.0% (5.9-8.1%)**  **N = 125** | **8.1% (6.8-9.4%)**  **N = 153** | **7.8% (6.6-9.1%)**  **N = 152** | **8.1% (6.3-9.9%)**  **N = 159** | **8.3% (6.7-9.9%)**  **N = 167** | **7.8% (6.8-8.9%)**  **N = 162** | **8.4% (7.0-9.8%)**  **N = 177** |
| **Age** |  |  |  |  |  |  |  |  |
| 20-39 years \* | 0.3% (0.1-0.4%) | 1.2% (0.6-1.8%) | 0.6% (0.1-1.1%) | 0.3% (0.0-0.7%) | 0.2% (0.0-0.5%) | 0.7% (0.0-1.5%) | 0.7% (0.1-1.3%) | 1.1% (0.3-1.9%) |
| 40-64 years | 4.0% (3.3-4.8%) | 5.1% (3.7-6.5%) | 6.3% (3.7-8.9%) | 4.8% (3.2-6.4%) | 5.7% (3.8-7.5%) | 5.5% (3.4-7.7%) | 4.8% (3.8-5.7%) | 6.0% (4.5-7.6%) |
| 65-79 years | 20.2% (17.9-22.6%) | 22.8% (19.1-26.6%) | 25.3% (22.1-28.5%) | 26.1% (21.9-30.3%) | 24.8% (21.4-28.3%) | 27.4% (22.8-31.9%) | 25.0% (22.8-27.2%) | 23.5% (19.6-27.4%) |
| ≥80 years | 38.4% (34.5-42.3%) | 49.9% (39.8-59.9%) | 59.2% (51.8-66.6%) | 55.3% (50.4-60.1%) | 52.0% (45.8-58.3%) | 47.1% (39.8-54.5%) | 48.7% (44.4-53.1%) | 49.8% (42.7-57.0%) |
| **Sex** |  |  |  |  |  |  |  |  |
| Male | 4.3% (3.6-4.9%) | 5.4% (4.5-6.3%) | 6.7% (5.3-8.2%) | 6.2% (5.3-7.1%) | 6.2% (4.7-7.8%) | 6.7% (4.8-8.6%) | 6.1% (4.9-7.3%) | 6.8% (5.3-8.3%) |
| Female | 6.9% (6.0-7.8%) | 8.4% (6.7-10.2%) | 9.4% (8.0-10.8%) | 9.4% (7.7-11.1%) | 9.8% (7.4-12.2%) | 9.7% (7.8-11.6%) | 9.5% (8.2-10.8%) | 9.9% (8.2-11.6%) |
| **Race/ethnicity** |  |  |  |  |  |  |  |  |
| Non-Hispanic white | 6.4% (5.6-7.1%) | 7.8% (6.5-9.2%) | 9.8% (8.4-11.3%) | 9.1% (7.8-10.3%) | 9.7% (7.7-11.6%) | 10.0% (8.0-12.1%) | 9.3% (8.1-10.5%) | 10.0% (8.1-11.9%) |
| Non-Hispanic black | 3.6% (3.1-4.2%) | 5.1% (3.7-6.6%) | 5.1% (3.6-6.6%) | 4.9% (3.7-6.1%) | 5.0% (3.4-6.6%) | 5.3% (3.8-6.8%) | 6.3% (5.0-7.7%) | 6.5% (5.1-8.0%) |
| Other race/ethnicity | 2.8% (1.4-4.1%) | 4.7% (2.7-6.8%) | 2.9% (1.0-4.8%) | 4.5% (2.9-6.0%) | 3.2% (1.6-4.7%) | 3.4% (2.2-4.7%) | 3.8% (2.8-4.8%) | 4.5% (3.6-5.5%) |
| **Diabetes status** |  |  |  |  |  |  |  |  |
| With diabetes mellitus | 16.2% (14.0-18.5%) | 16.3% (12.9-19.6%) | 19.2% (13.9-24.5%) | 21.9% (17.0-26.8%) | 20.2% (15.7-24.8%) | 18.3% (14.6-22.1%) | 22.3% (18.9-25.7%) | 20.2% (16.9-23.5%) |
| Without diabetes mellitus | 4.8% (4.3-5.3%) | 6.2% (5.1-7.3%) | 7.1% (5.7-8.5%) | 6.3% (5.1-7.5%) | 6.8% (4.9-8.7%) | 7.0% (5.4-8.6%) | 6.1% (5.2-6.9%) | 6.9% (5.3-8.5%) |

\*estimates in this row have large relative standard error (RSE) and thus may be less reliable

**Supplemental Table 5. Prevalence (percentage) of CKD (by MDRD equation) with expanded definition which includes albuminuria ≥30 mg/g regardless of eGFR level by demographic and diabetic categories, NHANES 1988-1994 through 2011-2012;** 95% confidence interval of prevalence (as percentage) are shown in parentheses; N represents the population number in 100,000's (number of significant digits varies by number of sampled NHANES participants in each cell)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Years** | | | | | | | | |
|  | **1988-1994** | **1999-2000** | **2001-2002** | **2003-2004** | **2005-2006** | **2007-2008** | **2009-2010** | **2011-2012** |
| **Total Population** | **12.5% (11.6-13.3%)**  **N = 209.2** | **14.6% (13.0-16.2%)**  **N = 262** | **15.2% (13.6-16.8%)**  **N = 286** | **14.7% (13.0-16.4%)**  **N = 287** | **15.4% (13.0-17.7%)**  **N = 303** | **15.9% (14.2-17.5%)**  **N = 320.5** | **13.8% (12.7-15.0%)**  **N = 286** | **15.6% (13.8-17.4%)**  **N = 327** |
| **Age** |  |  |  |  |  |  |  |  |
| 20-39 | 5.0% (4.3-5.8%) | 7.1% (4.9-9.3%) | 5.5% (3.9-7.1%) | 5.2% (3.6-6.8%) | 6.2% (5.2-7.1%) | 6.4% ( 4.9-7.8%) | 5.3% (4.2-6.3%) | 6.9% (5.5-8.3%) |
| 40-64 | 11.2% (10.0-12.4%) | 12.8% (10.8-14.8%) | 14.0% (11.3-16.6%) | 11.6% (9.6-13.6%) | 13.0% (10.0-16.1%) | 12.8% (10.7-15.0%) | 10.6% (9.3-11.8%) | 12.8% (10.5-15.2%) |
| 65-79 | 31.3% (28.1-34.4%) | 34.5% (31.4-37.6%) | 37.4% (33.0-41.9%) | 37.6% (32.4-42.7%) | 34.1% (30.5-37.7%) | 39.7% (36.7-42.6%) | 34.2% (30.9-37.5%) | 33.3% (30.1-36.5%) |
| ≥80 | 52.3% (48.2-56.5%) | 65.5% (58.1-73.0%) | 68.5% (61.7-75.3%) | 66.4% (62.3-70.6%) | 65.2% (59.7-70.8%) | 60.8% (51.1-70.5%) | 59.3% (54.0-64.6%) | 64.2% (57.3-71.1%) |
| **Sex** |  |  |  |  |  |  |  |  |
| Male | 10.0% (8.7-11.3%) | 12.0% (10.3-13.7%) | 13.5% (11.7-15.4%) | 13.3% (11.5-15.1%) | 12.4% (9.7-15.0%) | 13.5% (11.4-15.6%) | 11.9% (10.8-13.0%) | 13.8% (11.0-16.6%) |
| Female | 14.7% (13.5-16.0%) | 17.0% (14.9-19.1%) | 16.8% (15.1-18.5%) | 16.1% (14.1-18.1%) | 18.1% (15.4-20.9%) | 18.1% (16.1-20.1%) | 15.7% (13.9-17.5%) | 17.2% (15.3-19.1%) |
| **Race/ethnicity** |  |  |  |  |  |  |  |  |
| Non-Hispanic white | 12.6% (11.4-13.8%) | 14.6% (12.9-16.3%) | 16.1% (14.5-17.8%) | 14.8% (12.9-16.6%) | 15.8% (13.1-18.4%) | 16.9% (14.8-19.0%) | 14.6% (13.2-15.9%) | 15.9% (13.7-18.2%) |
| Non-Hispanic black | 13.6% (12.7-14.6%) | 14.2% (11.9-16.5%) | 14.9% (11.9-17.9%) | 14.4% (11.3-17.6%) | 15.3% (12.6-18.1%) | 15.2% (12.3-18.1%) | 14.3% (11.9-16.6%) | 17.5% (15.5-19.4%) |
| Other race/  ethnicities | 10.6% (8.2-13.0%) | 14.8% (11.7-17.9%) | 11.7% ( 9.3-14.1%) | 14.7% (11.6-17.9%) | 13.7% (11.0-16.4%) | 12.4% (10.3-14.5%) | 11.2% (9.0-13.3%) | 13.5% (10.9-16.2%) |
| **Diabetes status** |  |  |  |  |  |  |  |  |
| With diabetes mellitus | 39.3% (36.1-42.4%) | 36.8% (31.8-41.8%) | 44.2% (38.7-49.7%) | 42.0% (37.0-47.0%) | 40.0% (33.7-46.3%) | 39.0% (35.9-42.2%) | 37.3% (32.4-42.2%) | 37.4% (33.6-41.2%) |
| Without diabetes mellitus | 10.3% (9.6-11.0%) | 12.8% (11.2-14.4%) | 12.6% (10.7-14.5%) | 11.8% (9.8-13.7%) | 12.8% (10.3-15.2%) | 12.9% (11.2-14.7%) | 11.0% (9.9-12.1%) | 12.8% (11.1-14.4%) |

**Supplemental Table 6. Temporal trends in the U.S. population prevalence of chronic kidney disease derived from the National Health and Nutrition Examination Surveys from prior peer-reviewed publications (adapted from Hsu RK, Hsu CY. Am J Kidney Dis 2013; 62:214-6)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Study** | **CKD definition** | **Disease prevalence during time period** | | | **Change in prevalence per year** | **GFR estimating equation** | **Filtration marker calibration and alignment** |
|  |  | **1976-1980** | **1988-1994** | **1999-2004** |  |  |  |
| Hsu Annals 20041 | eGFRcr <60 | 2.0%a | 2.5%a |  | +1.7% per yearb | 4-variable MDRD Study Equation6 | For both time periods, Cleveland Clinic calibrated Cr = Cr - 0.23 |
| Coresh JASN 2005[2](#_ENREF_3) | CKD stages 1-4 (eGFRcr and ACR) |  | 8.8% | 9.4%  (1999-2000) | +0.8% per year | 4-variable MDRD Study Equation6 | 1988-1994: Cleveland Clinic calibrated Cr = Cr - 0.23;  1999-2000: Cleveland Clinic calibrated Cr = Cr + 0.13 |
| eGFRcr <60 | 4.4% | 3.8%  (1999-2000) | -1.7% per year |
| Coresh JAMA 2007[3](#_ENREF_4) | CKD stages 1-4 (eGFRcr and ACR) | 10.0% | 13.1% | +2.6% per yearb | IDMS-traceable MDRD Study Equation7 | 1998-1994: standardized Cr = -0.184 + 0.960\*Cr;  1999-2000: standardized Cr = 0.147+1.013\*Cr;  2000-4:no calibration  Conservative trend analysis added 0.04mg/dl to 1988-1994 creatinine values |
| eGFRcr <60  *(primary analysis)* | 5.6% | 8.1% | +3.5% per yearb |  |
| eGFRcr <60  *(conservative trend analysis)* | data not shown | data not shown | +1.4% per yearb |  |
| Foley CJASN 2009[4](#_ENREF_5) | CKD stages 1-5 (eGFRcyc and ACR) | 15.1% | 14.9%  (1999-2002) | -0.1% per year | CKD-EPI cystatin C 20088 | No calibration performed for cystatin C. |
| eGFRcys <60 | 6.4% | 6.9%  (1999-2002) | +0.8% per year |
| Grams AJKD 2013[5](#_ENREF_1) | eGFRcys <60 | 5.5% | 8.7%  (1999-2002) | +4.9% per yearb | CKD-EPI Cystatin C 20129 | 1988-1994: standardized cystatin C = 1.12\*[0.022+0.80\*(cystatin C)];    1999-2002: standardized cystatin C = 1.12\*[cystatin C-0.12] |
| eGFRcr-cys <60 | 4.4% | 7.1%  (1999-2002) | +5.0% per yearb | CKD-EPI Cr-cystatin C 20129 |

Abbeviations: eGFRcr, creatinine-based estimated glomerular filtration rate (ml/min/1.73m2); ACR, albumin-to-creatinine ratio; eGFRcys, cystatin

C-based estimated glomerular filtration rate (ml/min/1.73m2); eGFRcr-cys, creatinine and cystatin C-based estimated glomerular filtration rate (ml/min/1.73m2); MDRD, Modification of Diet in Renal Disease; IDMS, isotope dilution mass spectrometry; CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; Cr, creatinine (mg/dL)

afor age 20-74 blacks and whites only

brepresents statistically significant change in the original study

1. Hsu CY, Vittinghoff E, Lin F, Shlipak MG. The incidence of end-stage renal disease is increasing faster than the prevalence of chronic renal insufficiency. Ann Intern Med. 2004;141(2):95-101.

2. Coresh J, Byrd-Holt D, Astor BC, et al. Chronic kidney disease awareness, prevalence, and trends among US adults, 1999 to 2000. J Am Soc Nephrol. 2005;16(1):180-188.

3. Coresh J, Selvin E, Stevens L, et al. Prevalence of chronic kidney disease in the United States. JAMA. 2007;298(17):2038-2047.

4. Foley RN, Wang C, Snyder JJ, Collins AJ. Cystatin C levels in US adults, 1988-1994 versus 1999-2002: NHANES. Clin J Am Soc Nephrol. 2009;4(5):965-972.

5. Grams ME, Juraschek SP, Selvin E, et al. Trends in the prevalence of reduced GFR in the United States: a comparison of creatinine- and cystatin C-based estimates. Am J Kidney Dis. 2013;62(2):253-260.

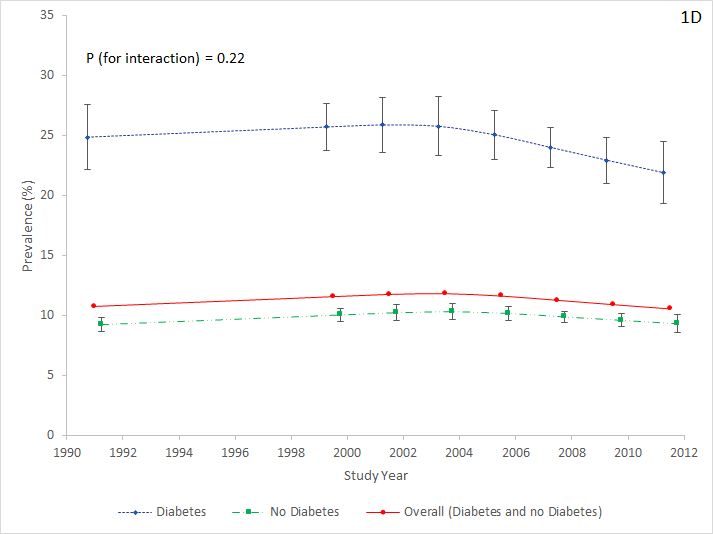
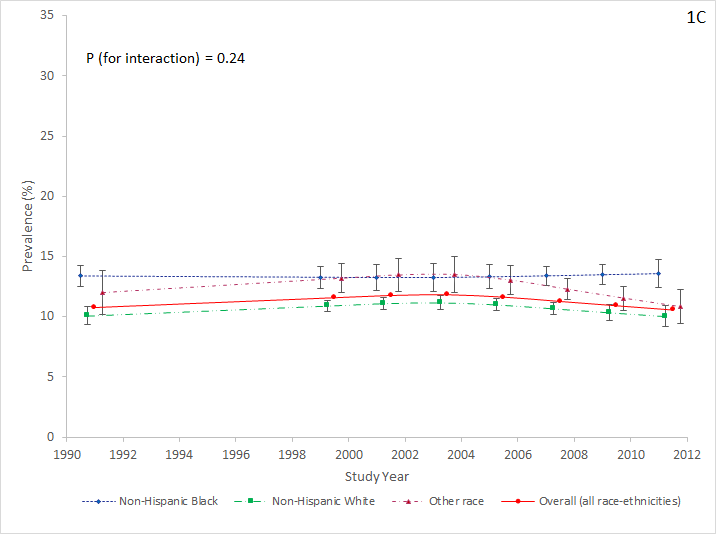
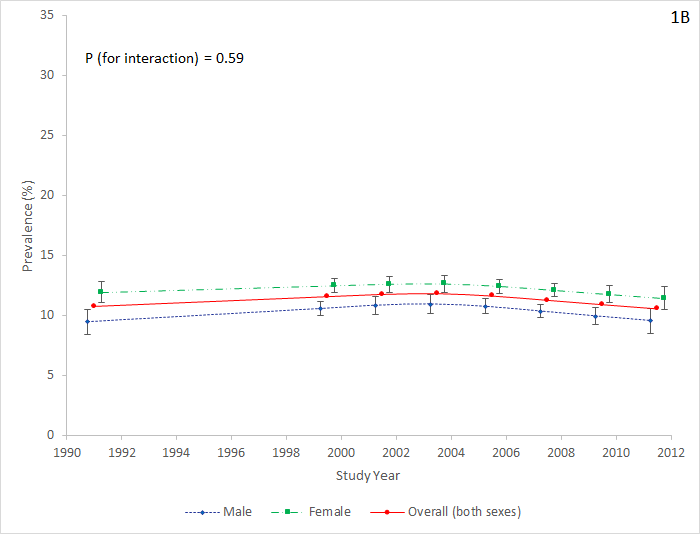
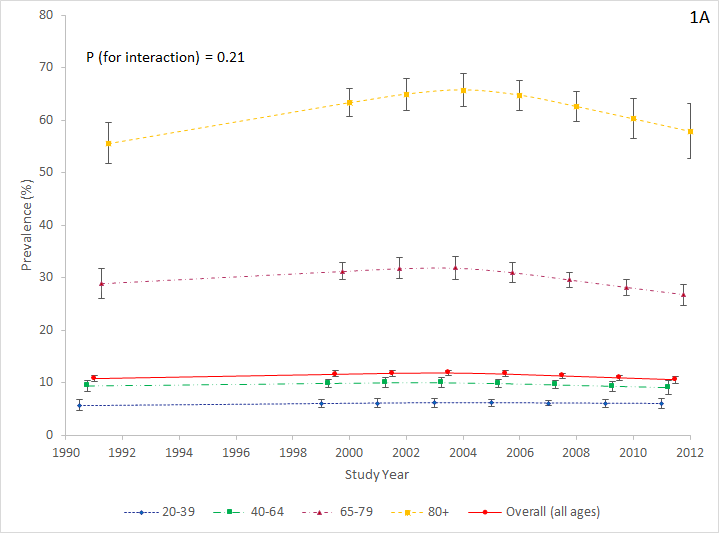
6. Levey AS, Greene T, Kusek JW, Beck GJ. A simplified equation to predict glomerular filtration rate from serum creatinine [abstract]. J Am Soc Nephrol. 2000;11:155A.

7. Levey AS, Coresh J, Greene T, et al. Using standardized serum creatinine values in the Modification of Diet in Renal Disease Study equation for estimating glomerular filtration rate. Ann Intern Med. 2006;145(4):247-254.

8. Stevens LA, Coresh J, Schmid CH, et al. Estimating GFR using serum cystatin C alone and in combination with serum creatinine: a pooled analysis of 3,418 individuals with CKD. Am J Kidney Dis. 2008;51(3):395-406.

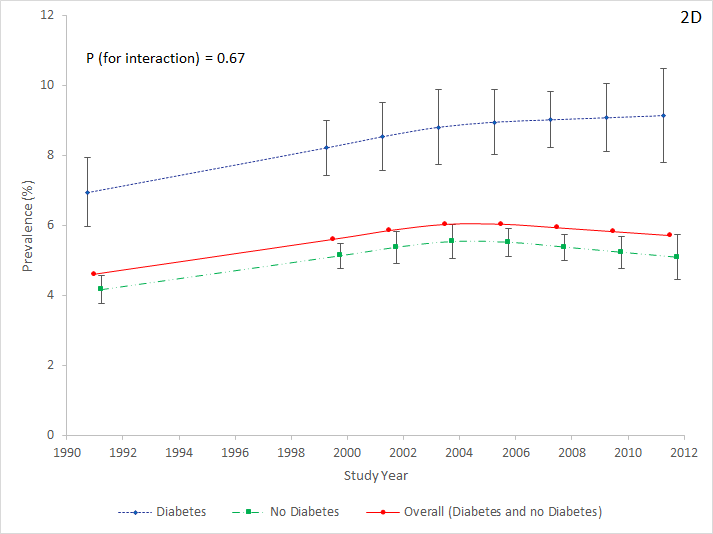
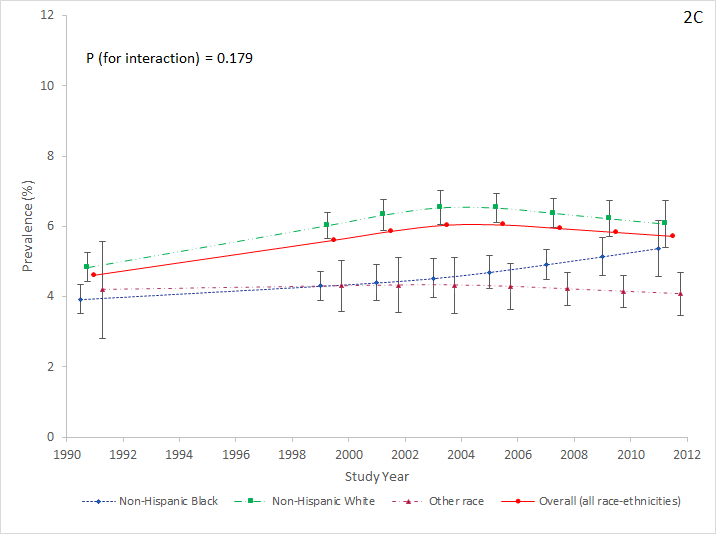
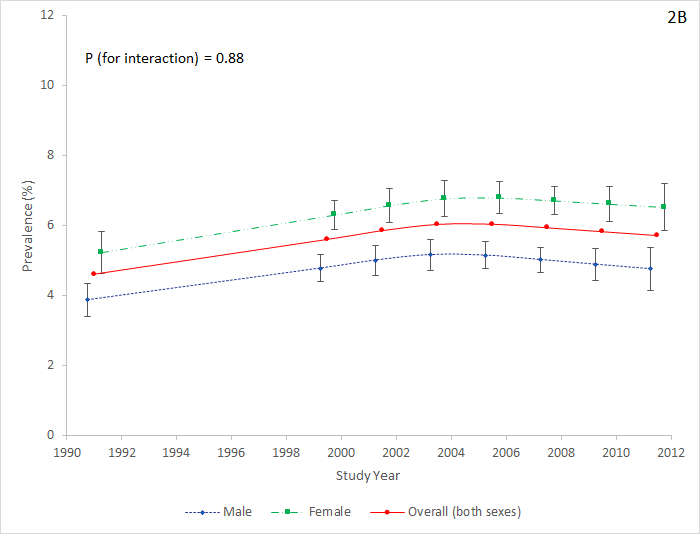
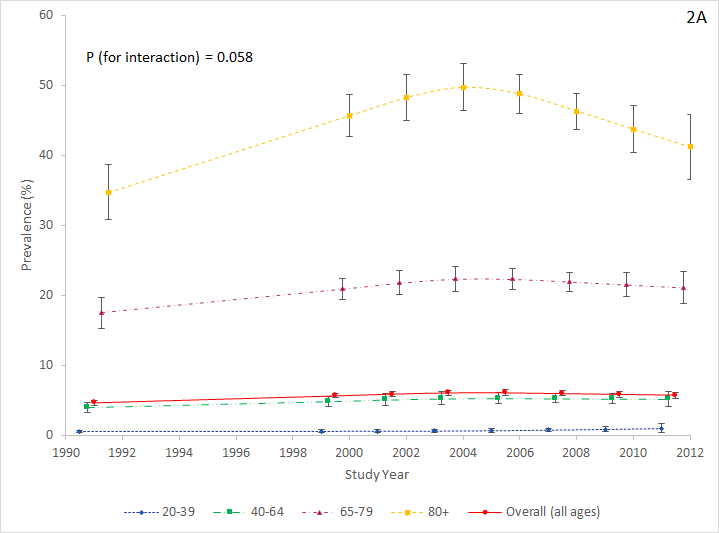
9. Inker LA, Schmid CH, Tighiouart H, et al. Estimating glomerular filtration rate from serum creatinine and cystatin C. N Engl J Med. 2012;367(1):20-29.

**Supplemental Figure 1. Adjusted prevalence (as percentage) of CKD (by CKD-EPI equation) with expanded definition which includes albuminuria ≥30 mg/g regardless of eGFR level by age (1A), sex (1B), race/ethnicity (1C), and presence or absence of diabetes mellitus (1D), National Health and Nutritional Examination Survey (NHANES) 1988-1994 through 2011-2012**

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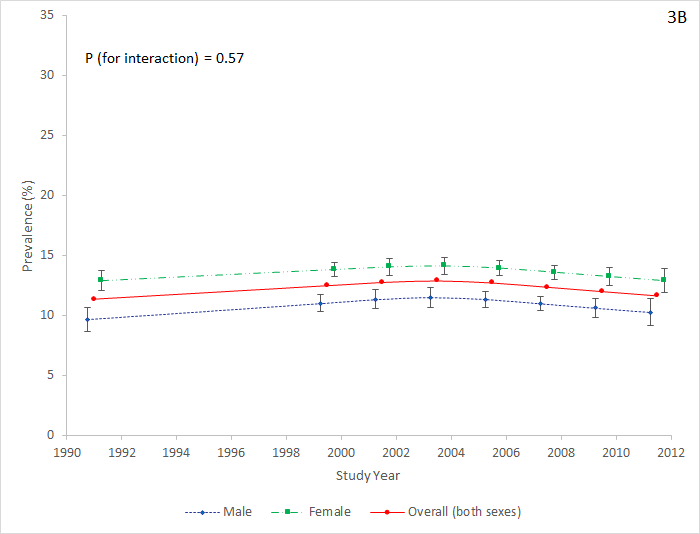
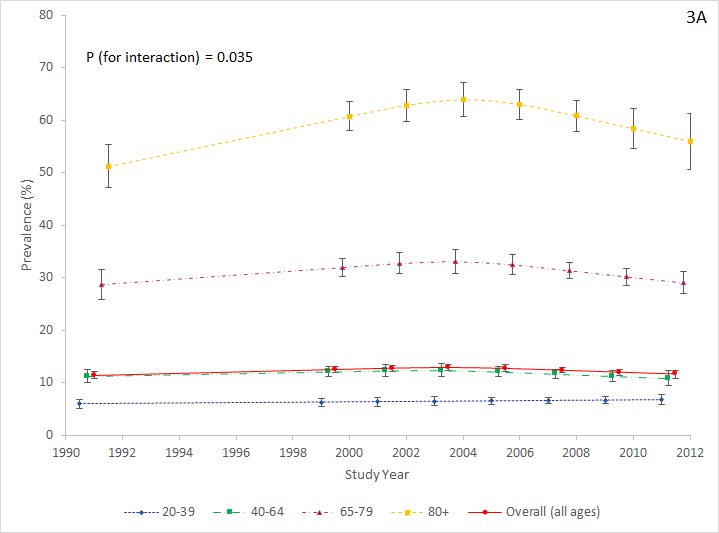
Each subgroup is adjusted for the other three subgroup variables (e.g. 1A is adjusted for sex, race/ethnicity, and diabetes status).

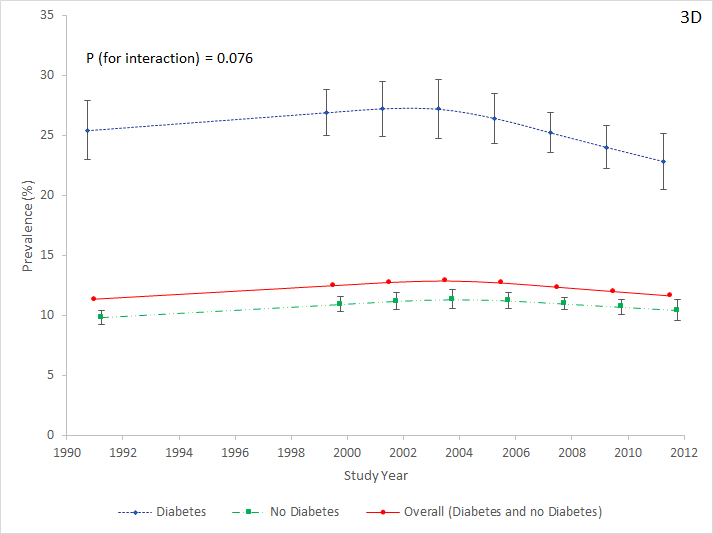
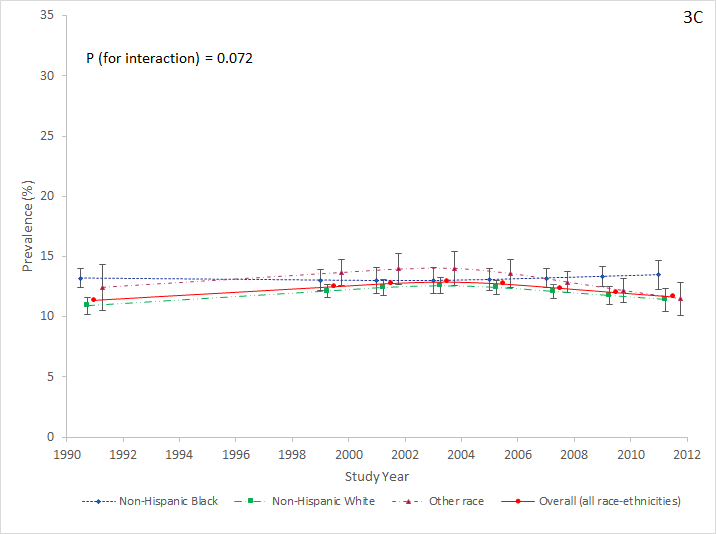
**Supplemental Figure 2. Adjusted prevalence (as percentage) of chronic kidney disease (CKD) stages 3-4 (by Modification of Diet in Renal Disease study [MDRD] equation) in U.S. adults by age (2A), sex (2B), race/ethnicity (2C) and presence or absence of diabetes mellitus (2D)**

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Each subgroup is adjusted for the other three subgroup variables (e.g. 2A is adjusted for sex, race/ethnicity, and diabetes status).

**Supplemental Figure 3. Adjusted prevalence (as percentage) of CKD (by MDRD equation) with expanded definition which includes albuminuria ≥30 mg/g regardless of estimated glomerular filtration rate (eGFR) level by age (3A), sex (3B), race/ethnicity (3C), and presence or absence of diabetes mellitus (3D)**





Each subgroup is adjusted for the other three subgroup variables (e.g. 3A is adjusted for sex, race/ethnicity, and diabetes status).