Supplementary materials

Adherence to the ADA's glycemic goals in the treatment of diabetes among older Americans, 2001-2018

Phuc Le, PhD, MPH, Gina Ayers, PharmD, Anita Misra-Hebert, MD, MPH,
Shoshana J. Herzig, MD, MPH, William H. Herman, MD, MPH, Victoria A. Shaker, BS,
Michael B. Rothberg, MD, MPH

Appendix table 1. Comparison of health status categories between the ADA's Standards of Care and NHANES-based definition

Health status	ADA's Standards of Care criteria	NHANES-based definition
Poor	Long-term care or ≥1 end-stage chronic illness	
	stage III–IV congestive heart failure	Ever told to have congestive heart failure plus having "much difficulty" or "unable to do" to walk between rooms
	oxygen-dependent lung disease	Ever told to have emphysema, chronic bronchitis, or chronic obstructive pulmonary disease plus having "much difficulty" or "unable to do" to walk between rooms
	chronic kidney disease requiring dialysis	eGRF<15 mL/min/1.73 m2 or received dialysis in past 12 months
	uncontrolled metastatic cancer	not included due to lack of data
	significantly reduce life expectancy	≥18 points on the Schonberg Index
	Moderate-to-severe cognitive impairment	Not included due to lack of data on severity of cognitive impairment
	≥2 ADL dependencies	Having "much difficulty" or "unable to do" regarding dressing; using fork, knife, cup; walking between rooms; and getting in and out of bed
Intermediate	≥3 coexisting chronic illnesses (conditions that are serious enough to require medications or lifestyle management) including:	
	arthritis, cancer, congestive heart failure, myocardial infarction, stroke	Ever told to have each of the conditions
	lung disease	Ever told to have emphysema, chronic bronchitis, or chronic obstructive pulmonary disease
	hypertension	Systolic blood pressure ≥140 mmHg, diastolic blood pressure ≥90 mmHg, or use of antihypertensive drugs
	stage III or worse chronic kidney disease	eGFR<60 mL/min/1.73 m2
	incontinence	Answering yes to "at least a few times a week" for questions "urinated before reaching the toilet" or "leak urine during nonphysical activities"
	depression	Patient Health Questionnaire (PHQ-9) score ≥10 for cycles 2005-2018, no information in 2000-2004 cycles
	falls	Not included due to lack of data
	Mild-to-moderate cognitive impairment	Answering yes to the question "are you limited in any way because of difficulty remembering or because you experience periods of confusion?" without meeting other criteria for poor health
	2+ instrumental ADL impairments	Having "much difficulty" or were "unable to do" managing money, doing house chores, preparing meals, and going out to movies/events. No information about other iADLs was available
Good	Few coexisting chronic illnesses, intact cognitive and functional status	Patients who are not in the poor and intermediate health groups

Note: ADA, American Diabetes Association; ADL, activity of daily living; eGFR, estimated glomerular filtration rate; NHANES, National Health and Nutrition Examination Survey

Appendix Table 2. Prevalence (%) of patients with an HbA1c below goal by era in US older adults (≥ 65 years) with diabetes who received at least one diabetes medication, 2001-2018 - Sensitivity analysis

	All survey cycles (2001-2018)	2001-2004	2005-2012	2013-2018	p-value for trend
Definition 1: HbA1c ≥1% below target plus use of medications associated with a higher risk of hypoglycemia[*]					
All patients	15 (12-17)	12 (8-17)	12 (10-15)	18 (14-22)	0.031
By health status					
Good health	7 (5-9)	NR	7 (4-12)	4 (2-7)	0.006
Intermediate health	17 (14-21)	10 (6-15)	11 (8-16)	26 (19-33)	<0.001
Poor health	40 (30-51)	NR	NR	NR	NA
Definition 2: HbA1c <7% plus use of medications associated with a higher risk of hypoglycemia					
All patients	31 (28-34)	47 (41-52)	38 (34-42)	20 (16-25)	<0.001
By health status					
Good health	26 (22-30)	52 (41-63)	34 (28-41)	12 (8-17)	<0.001
Intermediate health	34 (30-38)	42 (34-51)	40 (34-46)	26 (19-33)	0.001
Poor health	35 (26-45)	NR	NR	20 (11-34)	0.012

Note: Analyses were limited to patients with available HbA1c values who received at least one diabetes medication. Data are percentage (95% CI). All estimates were calculated accounting for the complex survey design. [*]The American Diabetes Association's glycemic targets were specific for patient health status and time period.[1-5] NA, not applicable; NR, not reported based on the National Center for Health Statistics Data Presentation Standards for Proportions.[6]

Appendix Table 3. Prevalence (%) of patients with an HbA1c below goal by era in US older adults (≥ 65 years) who reported a diagnosis of diabetes, 2001-2018 - Sensitivity analysis

	All survey cycles (2001-2018)	2001-2004	2005-2012	2013-2018	p-value for trend
Definition 1: HbA1c ≥1% below target plus use of medications associated with a higher risk of hypoglycemia[*]					
All patients	13 (11-15)	9 (6-14)	10 (8-13)	16 (12-20)	0.010
By health status					
Good health	6 (4-8)	NR	6 (4-11)	4 (2-7)	0.025
Intermediate health	15 (12-18)	8 (5-12)	10 (7-14)	22 (16-28)	<0.001
Poor health	32 (24-42)	NR	33 (22-47)	NR	NA
Definition 2: HbA1c <7% plus use of medications associated with a higher risk of hypoglycemia					
All patients	26 (24-29)	36 (30-42)	33 (29-36)	18 (14-22)	<0.001
By health status					
Good health	23 (19-27)	41 (31-51)	30 (25-36)	11 (8-17)	<0.001
Intermediate health	28 (25-32)	32 (25-40)	34 (29-39)	22 (16-28)	0.012
Poor health	28 (21-37)	NR	33 (22-47)	18 (11-30)	0.040

Note: Analyses were limited to patients with available HbA1c values who reported a diagnosis of diabetes. Data are percentage (95% CI). All estimates were calculated accounting for the complex survey design. [*]The American Diabetes Association's glycemic targets were specific for patient health status and time period.[1-5] NA, not applicable; NR, not reported based on the National Center for Health Statistics Data Presentation Standards for Proportions.[6]

Appendix Table 4. Use of diabetes medications by health status in US older adults (≥ 65 years) with diabetes, 2001-2018

	Overall	Health status			p-value
		Good health	Intermediate health	Poor health	
Number of drugs, mean	1.1 (1.1-1.2)	1.1 (1-1.2)	1.2 (1.1-1.2)	1.2 (1-1.3)	0.264
Any drug, %	68 (66-70)	66 (63-70)	69 (65-72)	72 (64-78)	0.407
One drug, %	34 (32-36)	34 (31-38)	33 (31-36)	37 (30-44)	0.595
Two drug, %	24 (22-26)	23 (20-26)	25 (22-28)	25 (18-33)	0.585
Three or more drugs, %	10 (9-11)	9 (7-11)	11 (9-13)	10 (5-18)	0.586

Note: All patients with diagnosed and undiagnosed diabetes were included in this analysis. Data are mean or percentage (95% CI). All estimates were calculated accounting for the complex survey design.

Appendix Table 5. Prevalence of patients using of diabetes medication by drug class and health status in US older adults (≥65 years) with diabetes, 2001-2018

Drug class	All patients	Health status			p-value
		Good health	Intermediate health	Poor health	
A. Among patients who used at least one diabetes medication					
Metformin	61 (58-63)	75 (71-78)	54 (50-58)	37 (28-46)	<0.001
Sulfonylureas	44 (41-47)	41 (37-45)	46 (42-50)	43 (35-52)	0.162
SGLT2i	1 (0-1)	0 (0-1)	1 (0-2)	0 (0-0)	0.442
GLP-1 RA	1 (1-2)	1 (0-2)	2 (1-3)	3 (0-19)	0.435
DDP-4i	9 (7-10)	7 (6-10)	9 (7-11)	13 (8-20)	0.110
Thiazolidinediones	12 (11-14)	12 (9-15)	13 (10-16)	11 (6-19)	0.808
Insulin	27 (25-30)	20 (16-23)	31 (28-34)	43 (34-54)	<0.001
B. Among patients who reported a diagnosis of diabetes					
Metformin	50 (47-53)	64 (60-68)	44 (40-48)	30 (23-38)	<0.001
Sulfonylureas	37 (34-39)	36 (32-40)	38 (34-41)	34 (27-43)	0.557
SGLT2i	1 (0-1)	0 (0-1)	1 (0-2)	0 (0-0)	0.500
GLP-1 RA	1 (1-2)	1 (0-2)	1 (1-3)	3 (0-16)	0.485
DDP-4i	7 (6-9)	6 (5-8)	8 (6-10)	10 (6-16)	0.188
Thiazolidinediones	10 (9-12)	10 (8-13)	11 (9-13)	9 (5-16)	0.877
Insulin	24 (22-26)	18 (15-21)	26 (24-29)	36 (28-45)	<0.001

Note: Data are percentage (95% CI). All estimates were calculated accounting for the complex survey design. DPP-4i, dipeptidylpeptidase 4 inhibitors; GLP-1 RA, glucagon-like peptide-1 receptor agonists; SGLT2i, sodium-glucose cotransporter-2 inhibitors.

Appendix Table 6: Association between patient health status and receipt of diabetes medications associated with a higher risk of hypoglycemia in US older adults (≥65 years) with diabetes who received ≥1 medication, 2001-2018

Patient characteristics	Univariate analysis		Multivariable analysis	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Age (per 5-year increase)	1.21 (0.97 - 1.5)	0.087	1.23 (0.95 - 1.58)	0.111
Sex (ref.=female)	1.14 (0.77 - 1.68)	0.510		
BMI	1.01 (0.99 - 1.04)	0.336		
Nonwhite (ref.=White)	1.01 (0.66 - 1.53)	0.968		
High-school or higher (ref.=less than high-school)	0.85 (0.53 - 1.36)	0.499		
Uninsured (ref.=any insurance)	0.27 (0.07 - 1.04)	0.057	0.22 (0.06 - 0.79)	0.020
Income to poverty ratio (ref.= <1)				
1-<2	0.95 (0.54 - 1.65)	0.842		
2-<4	0.91 (0.48 - 1.75)	0.777		
≥4	0.72 (0.35 - 1.48)	0.367		
Smoking (ref. = never smokers)				
Former smokers	1.09 (0.67 - 1.78)	0.725	1.16 (0.66 - 2.03)	0.057
Current smokers	2.21 (1.12 - 4.35)	0.022	2.51 (1.03 - 6.12)	<0.001
Alcohol drinking (ref.=never drinkers)				
Some drinkers	1.01 (0.52 - 1.98)	0.972		
Excessive drinkes	1.90 (0.45 - 8.07)	0.383		
Health status group (ref.=good)				
Intermediate	2.52 (1.42 - 4.48)	0.002	1.99 (1.02 - 3.89)	0.043
Poor	5.08 (2.58 - 10.03)	<0.001	4.88 (2.29 - 10.4)	<0.001

Note: The analysis was limited to patients who received at least one diabetes medication and had an HbA1c less than glycemic target by 1% or more. The American Diabetes Association's glycemic targets were specific for patient health status and time period.[1-5] All estimates were calculated accounting for the complex survey design.
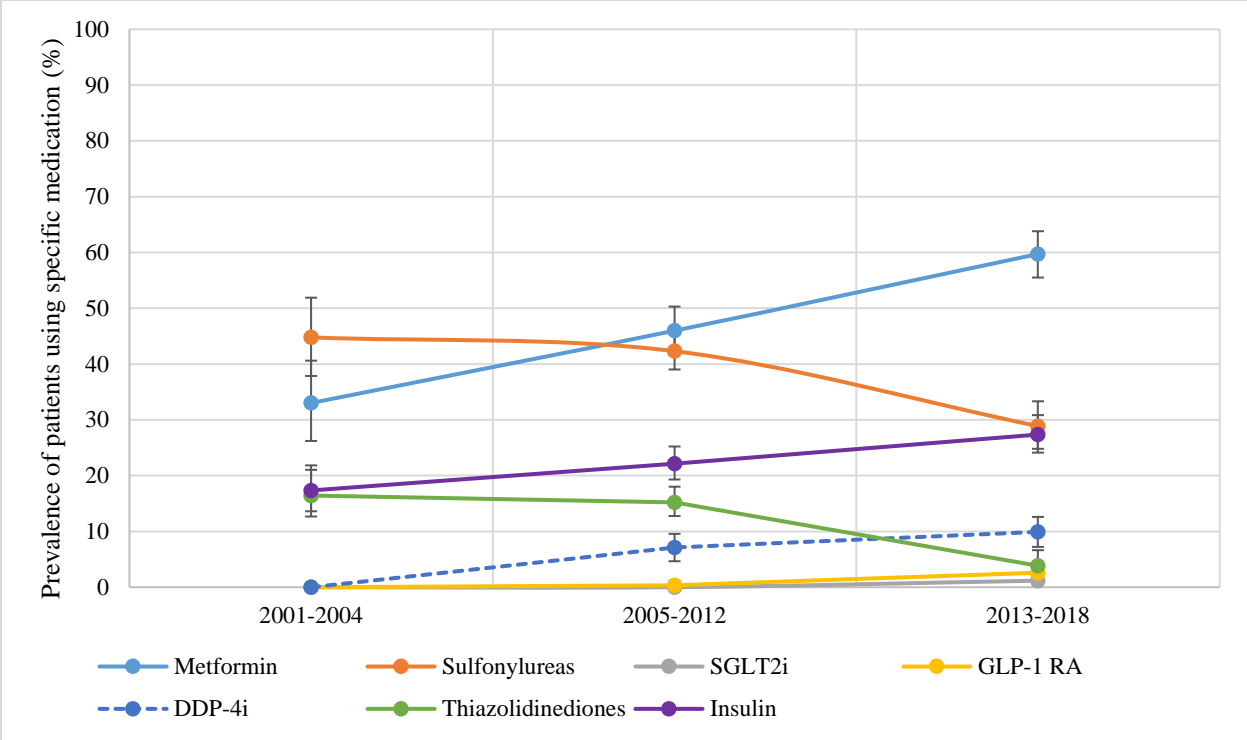
Appendix Table 7: Association between patient health status and receipt of diabetes medications associated with a higher risk of hypoglycemia in US older adults (≥65 years) who reported a diagnosis of diabetes, 2001-2018

| Patient characteristics	Univariate analysis		Multivariable analysis	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Age (per 5-year increase)	1.13 (0.94 - 1.37)	0.180	1.10 (0.90 - 1.35)	0.334
Sex (ref.=female)	1.23 (0.85 - 1.78)	0.267		
BMI	1.03 (1.00 - 1.06)	0.049	1.03 (0.99 - 1.06)	0.095
Nonwhite (ref.=White)	1.06 (0.72 - 1.57)	0.767		
High-school or higher (ref.=less than high-school)	0.98 (0.67 - 1.45)	0.926		
Uninsured (ref.=any insurance)	0.53 (0.14 - 1.97)	0.344		
Income to poverty ratio (ref.= <1)				
1-<2	1.31 (0.83 - 2.07)	0.238		
2-<4	1.14 (0.65 - 1.99)	0.644		
≥4	0.89 (0.49 - 1.6)	0.684		
Smoking (ref. = never smokers)				
Former smokers	1.12 (0.74 - 1.71)	0.582		
Current smokers	1.30 (0.61 - 2.75)	0.496		
Alcohol drinking (ref.=never drinkers)				
Some drinkers	1.06 (0.56 - 2.01)	0.856		
Excessive drinkes	1.82 (0.51 - 6.49)	0.353		
Health status group (ref.=good)				
Intermediate	1.92 (1.18 - 3.14)	0.009	1.75 (1.05 - 2.90)	0.032
Poor	3.36 (1.85 - 6.09)	<0.001	3.09 (1.59 - 6.03)	0.001

Note: The analysis was limited to patients who reported a diagnosis of diabetes and had an HbA1c less than glycemic target by 1% or more. The American Diabetes Association's glycemic targets were specific for patient health status and time period.[1-5] All estimates were calculated accounting for the complex survey design.
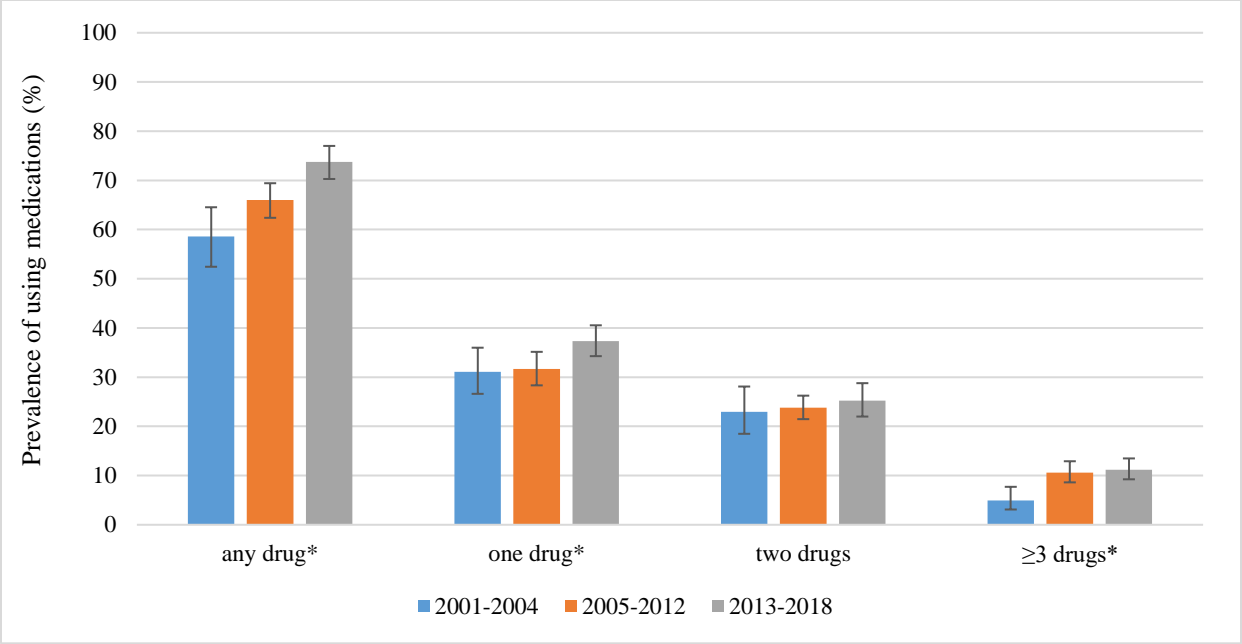
 Appendix Figure 1: Prevalence (%) of patients using diabetes medications by number of drugs in US older adults (≥65 years) with diabetes. The analysis included all patients with diagnosed and undiagnosed diabetes. All estimates were calculated accounting for the complex survey design. The vertical bars represent 95% confidence intervals. *P-value for trends was <0.05.

Appendix Figure 2: Prevalence (%) of patients using diabetes medications by drug class in US older adults (≥65 years) with diagnosed diabetes, 2001-2018. The analysis was limited to patients who reported a diagnosis of diabetes. All estimates were calculated accounting for the complex survey design. The vertical bars represent 95% confidence intervals. DPP-4i, dipeptidylpeptidase 4 inhibitors; GLP-1 RA, glucagon-like peptide-1 receptor agonists; SGLT2i, sodium-glucose cotransporter-2 inhibitors.

a. Time period
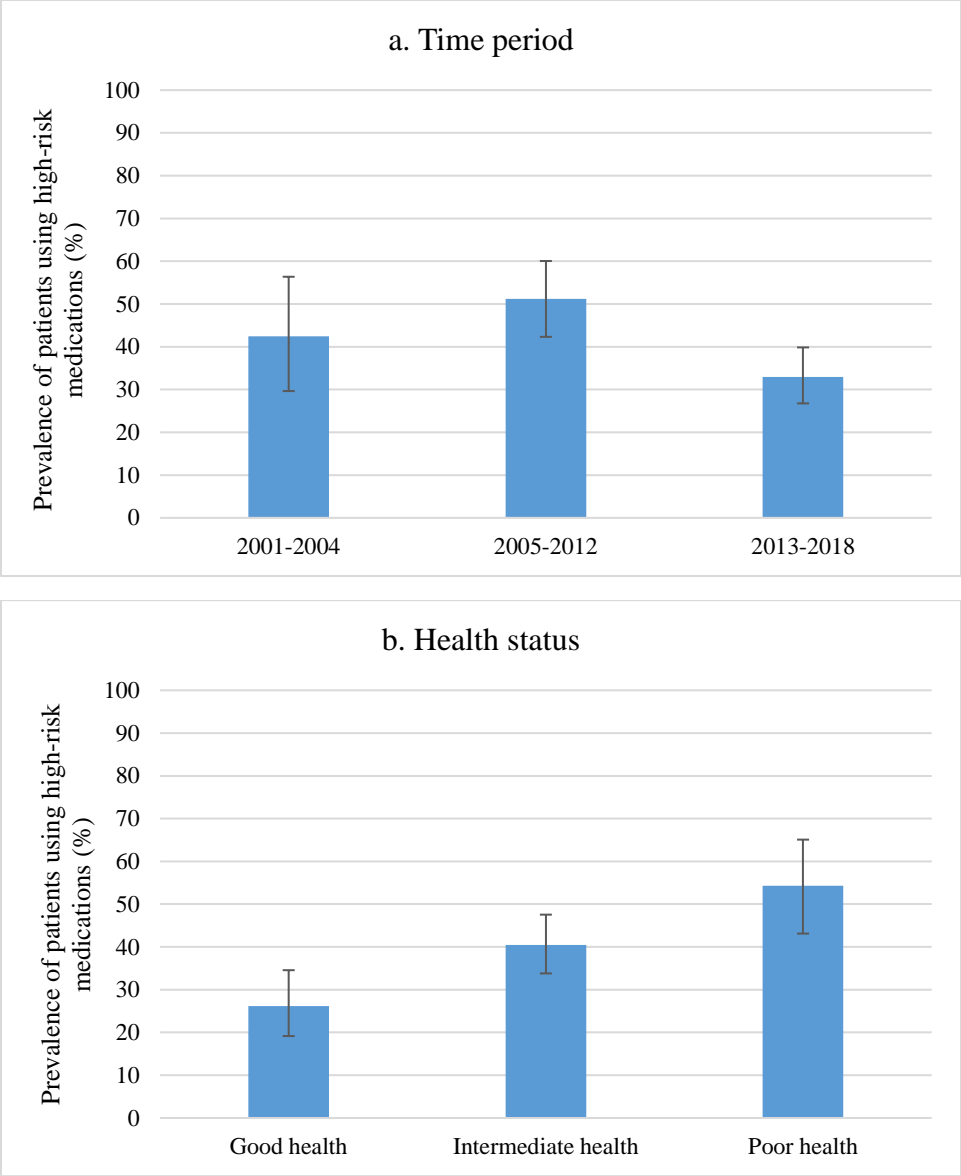
b. Health status

Appendix Figure 3. Prevalence (%) of patients using any diabetes medication associated with a higher risk of hypoglycemia among those who reported a diagnosis of diabetes and had an HbA1c below goal by a) time period and b) health status in US older adults (≥65 years) with diabetes. Being below goal was defined as having an HbA1c lower than the ADA's glycemic targets by 1% or more. The American Diabetes Association's glycemic targets were specific for patient health status and time period.[1-5] Medications associated with a higher risk of hypoglycemia included sulfonylureas, meglitinides, and insulin. The analysis was limited to patients who had available HbA1c values, received at least one diabetes medication, and had an HbA1c below goal. All estimates were calculated accounting for the complex survey design. The vertical bars represent 95% confidence intervals. Both the p-value for trends over time and p-value comparing across health status were <0.05.

Reference

1.	Kirkman MS, Briscoe VJ, Clark N, et al. Diabetes in older adults. *Diabetes Care.* 2012;35(12):2650-2664.
2.	American Diabetes Association. Standards of medical care in diabetes--2013. *Diabetes Care.* 2013;36 Suppl 1:S11-66.
3.	American Diabetes Association. Standards of medical care for patients with diabetes mellitus. *Diabetes Care.* 2003;26 Suppl 1:S33-50.
4.	American Diabetes Association. Standards of medical care in diabetes. *Diabetes Care.* 2004;27 Suppl 1:S15-35.
5.	Brown AF, Mangione CM, Saliba D, Sarkisian CA, California Healthcare Foundation/American Geriatrics Society Panel on Improving Care for Elders with D. Guidelines for improving the care of the older person with diabetes mellitus. *J Am Geriatr Soc.* 2003;51(5 Suppl Guidelines):S265-280.
6.	Parker JD, Talih M, Malec DJ, et al. National Center for Health Statistics Data Presentation Standards for Proportions. *Vital Health Stat 2.* 2017(175):1-22.