	HAQ Index (95% UI)						HAQ Index frontier		Difference between observed and frontier HAQ Index values	
	1990	1995	2000	2005	2010	2015	1990	2015	1990	2015
(Continued from previous page)										
Panama	52·9 (50·7–55·2)	56·7 (54·6–58·7)	59·8 (57·6–61·8)	61·3 (58·9–63·5)	62·2 (59·7–64·3)	64·4 (61·4–67·0)	71·6	79·9	18·7	15·5
Venezuela	53·1 (51·4–54·9)	55·6 (53·8–57·5)	59·3 (57·5–61·0)	62·3 (60·7–64·0)	64·2 (62·5–65·8)	64·7 (62·2–66·9)	71·4	78·5	18·3	13·8
Tropical Latin America	50·1 (48·3–52·0)	53·7 (52·0–55·6)	56·9 (55·3–58·7)	59·8 (58·3–61·4)	62·5 (61·0–64·1)	64·7 (63·2–66·5)	63·7	74·7	13·7	10·0
Brazil	50·1 (48·3–52·0)	53·8 (52·0–55·6)	57·0 (55·4–58·7)	59·9 (58·4–61·6)	62·6 (61·2–64·3)	64·9 (63·4–66·7)	63·8	74·7	13·8	9·8
Paraguay	53·0 (50·7–55·4)	55·1 (52·9–57·5)	56·6 (54·0–58·9)	57·4 (54·8–59·9)	58·6 (56·1–61·0)	60·4 (57·4–63·2)	61·7	74·0	8·7	13·6
North Africa and Middle East	43·8 (41·9–46·0)	46·5 (44·5–48·6)	49·9 (48·0–51·9)	52·8 (51·0–54·8)	55·7 (53·9–57·7)	58·4 (56·5–60·5)	55·7	72·3	11·9	13·8
Afghanistan	24·7 (18·6–32·0)	24·5 (18·5–31·6)	24·8 (18·7–31·7)	27·1 (21·2–33·5)	29·4 (23·5–35·7)	32·5 (26·6–38·6)	38·0	47·6	13·3	15·1
Algeria	48·2 (45·5–51·1)	52·6 (49·9–55·2)	56·2 (53·7–58·7)	59·6 (57·3–62·1)	62·2 (59·9–64·3)	63·7 (61·3–66·3)	58·3	71·4	10·1	7·6
Bahrain	59·7 (57·4–62·2)	63·2 (60·6–65·6)	67·3 (64·9–69·7)	71·3 (69·0–73·4)	77·2 (75·1–79·1)	79·0 (76·2–81·7)	71·8	82·3	12·1	3·3
Egypt	45·0 (42·5–47·5)	49·3 (47·1–51·7)	54·4 (52·4–56·4)	56·9 (54·8–58·7)	58·2 (56·2–60·1)	61·0 (58·7–63·1)	58·0	73·0	12·9	12·0
Iran	54·6 (51·5–57·6)	59·6 (56·5–62·3)	63·5 (60·9–65·6)	65·7 (62·6–68·6)	68·9 (65·4–72·3)	71·1 (67·9–74·2)	60·0	77·5	5·4	6·4
Iraq	51·1 (47·5–54·4)	50·7 (47·4–54·0)	51·8 (48·4–55·0)	54·4 (50·4–58·0)	57·2 (53·2–61·3)	60·1 (55·8–64·3)	53·2*	70·1	2·1	10·0
Jordan	59·1 (56·2–61·9)	62·0 (59·2–64·8)	65·0 (62·6–67·3)	68·4 (66·4–70·3)	74·3 (72·8–75·8)	76·5 (74·4–78·4)	63·1	76·3*	4·0	..
Kuwait	71·7 (70·1–73·3)	71·4 (70·0–72·8)	74·9 (73·6–76·1)	75·7 (74·5–77·0)	77·7 (76·4–78·9)	82·0 (79·9–84·0)	76·0	88·5	4·3	6·4
Lebanon	58·7 (55·3–62·2)	63·4 (60·1–66·5)	68·5 (65·2–71·7)	73·1 (69·7–76·4)	77·0 (73·4–80·9)	80·0 (76·0–84·3)	69·5	80·5*	10·9	0·6
Libya	60·0 (57·3–62·8)	63·7 (61·2–66·4)	65·4 (63·1–67·8)	67·1 (64·9–69·3)	69·7 (67·4–72·0)	69·9 (67·2–72·6)	61·5*	74·0	1·4	4·1
Morocco	44·0 (40·7–47·3)	47·8 (44·7–51·1)	52·6 (49·2–56·0)	55·6 (51·4–59·1)	58·7 (54·1–62·8)	61·3 (56·6–66·0)	49·4	63·0*	5·4	1·7
Palestine	61·8 (57·8–65·5)	65·6 (62·3–68·6)	68·3 (66·2–70·4)	68·7 (66·6–70·5)	69·0 (66·3–71·5)	70·5 (67·2–74·1)	55·8*	69·4*	..	..
Oman	66·1 (62·0–70·4)	71·4 (67·6–74·9)	74·4 (71·3–77·0)	76·2 (74·2–78·0)	72·9 (71·0–75·1)	77·1 (74·6–80·1)	54·3*	78·6*	..	1·5
Qatar	70·8 (68·1–73·3)	71·3 (68·8–73·8)	73·1 (70·9–75·6)	77·5 (75·0–79·7)	83·1 (80·7–85·3)	85·2 (82·0–88·3)	72·9*	84·5*	2·1	..
Saudi Arabia	63·4 (61·1–65·8)	66·8 (64·8–68·8)	71·2 (69·6–72·7)	74·2 (72·8–75·6)	77·0 (75·6–78·4)	79·4 (77·7–81·1)	65·4*	81·0*	2·0	1·6
Sudan	36·6 (32·4–41·0)	38·8 (34·1–43·2)	42·0 (37·2–46·7)	44·9 (40·1–49·6)	47·4 (42·6–52·5)	50·1 (45·0–55·1)	46·6	56·4	10·0	6·4
Syria	58·2 (54·9–61·2)	63·1 (59·5–66·2)	68·2 (65·3–70·7)	71·4 (69·0–73·4)	73·8 (71·9–75·5)	74·6 (72·1–77·0)	52·1*	70·4*	..	..
Tunisia	53·0 (50·3–55·7)	56·9 (54·2–59·4)	61·4 (59·0–64·0)	64·5 (61·6–67·4)	67·4 (64·3–70·7)	70·1 (66·6–73·8)	59·1	74·3	6·1	4·3
Turkey	51·3 (48·8–53·9)	55·4 (53·0–57·8)	62·4 (60·3–64·4)	68·6 (66·7–70·6)	74·3 (72·4–75·9)	76·2 (74·3–78·1)	65·2	75·9*	13·9	..
United Arab Emirates	56·9 (52·7–61·0)	60·8 (57·3–64·3)	64·7 (61·9–67·8)	69·0 (66·7–71·3)	71·4 (68·1–74·6)	72·2 (68·0–76·3)	73·7	89·2	16·8	17·1
Yemen	35·2 (27·7–43·5)	38·0 (30·3–46·6)	41·3 (32·8–50·0)	44·5 (36·1–53·3)	47·8 (38·8–56·0)	49·6 (40·4–57·6)	37·0*	54·1*	1·8	4·5

(Table 3 continues on next page)

	HAQ Index (95% UI)						HAQ Index frontier		Difference between observed and frontier HAQ Index values	
	1990	1995	2000	2005	2010	2015	1990	2015	1990	2015
(Continued from previous page)										
South Asia	30·7 (28·5–33·3)	32·9 (30·8–35·2)	35·1 (32·9–37·6)	38·1 (36·0–40·5)	41·1 (39·0–43·4)	44·4 (42·3–46·7)	48·5	66·3	17·7	21·9
Bangladesh	32·6 (29·5–35·7)	35·8 (32·8–38·8)	39·6 (36·8–42·4)	44·3 (41·7–47·2)	48·7 (46·1–51·4)	51·7 (48·4–54·9)	47·0	61·1	14·4	9·4
Bhutan	34·6 (30·4–38·8)	37·6 (33·9–41·7)	42·3 (38·6–45·8)	46·2 (42·4–49·8)	50·1 (46·4–53·9)	52·7 (48·5–56·7)	47·3	65·9	12·7	13·2
India	30·7 (28·4–33·5)	33·1 (30·8–35·6)	35·3 (32·9–37·9)	38·2 (36·0–40·7)	41·2 (38·9–43·6)	44·8 (42·6–47·2)	48·8	68·4	18·0	23·6
Nepal	34·0 (30·2–38·1)	37·1 (33·8–40·5)	41·6 (38·6–44·6)	45·7 (42·3–49·1)	48·2 (44·2–52·1)	50·8 (46·7–55·0)	44·4	55·7	10·4	4·9
Pakistan	36·5 (33·3–40·3)	35·6 (32·2–39·3)	36·3 (32·9–40·1)	38·1 (34·9–41·9)	41·2 (37·5–45·1)	43·1 (39·2–47·1)	47·2	60·7	10·6	17·7
Sub-Saharan Africa	32·3 (29·7–35·2)	33·5 (31·2–36·1)	34·6 (32·4–36·9)	37·4 (35·3–39·7)	40·5 (38·4–42·9)	42·2 (39·6–44·9)	46·6	52·3	14·3	10·1
Central sub-Saharan Africa	31·1 (25·9–36·8)	32·1 (27·0–37·4)	33·0 (27·8–37·8)	35·7 (30·0–41·0)	37·2 (30·9–42·7)	38·6 (31·8–45·6)	45·7	48·1	14·6	9·5
Angola	25·8 (12·2–43·4)	28·1 (12·9–45·2)	31·2 (15·3–47·8)	35·6 (18·3–51·1)	37·7 (18·7–52·1)	40·7 (20·3–54·9)	46·1	55·3	20·3	14·6
Central African Republic	25·5 (20·3–30·6)	25·8 (19·1–33·9)	26·7 (18·2–37·7)	28·0 (18·3–39·8)	28·8 (18·6–40·9)	28·6 (17·4–41·3)	44·0	47·3	18·6	18·7
Congo (Brazzaville)	32·2 (26·9–38·0)	31·4 (26·8–36·4)	33·3 (28·7–38·4)	39·3 (34·4–44·5)	41·2 (34·9–47·1)	43·5 (34·2–52·7)	53·6	65·5	21·4	22·0
DR Congo	35·6 (29·2–42·6)	36·1 (30·7–41·5)	36·2 (31·1–41·0)	38·1 (33·0–43·0)	39·3 (33·8–44·8)	40·4 (33·1–49·0)	44·7	45·2*	9·1	4·8
Equatorial Guinea	26·1 (12·0–45·2)	27·5 (12·5–46·7)	35·4 (17·5–50·6)	42·9 (23·0–55·3)	45·6 (25·6–57·1)	48·4 (27·9–59·4)	46·4	72·5	20·4	24·1
Gabon	39·1 (34·9–43·4)	40·1 (36·1–44·4)	41·8 (37·1–46·3)	44·1 (39·1–48·9)	48·4 (42·3–54·2)	51·4 (42·7–59·0)	61·1	74·0	22·0	22·6
Eastern sub-Saharan Africa	29·6 (27·1–32·7)	31·2 (28·6–34·1)	33·8 (31·3–36·6)	37·5 (35·0–40·1)	40·5 (37·4–43·6)	42·4 (38·6–46·2)	43·1	49·9	13·5	7·5
Burundi	23·5 (17·0–31·9)	23·4 (18·3–29·1)	27·0 (22·3–31·7)	35·5 (30·5–40·3)	40·5 (34·2–47·3)	40·4 (31·6–48·9)	39·9	45·3*	16·4	4·9
Comoros	32·7 (23·7–41·6)	34·3 (27·9–40·1)	38·4 (33·8–42·9)	44·1 (39·2–48·8)	47·2 (41·6–52·5)	47·7 (39·6–55·2)	46·0	50·5*	13·3	2·8
Djibouti	38·9 (30·8–47·1)	38·8 (29·0–48·0)	39·4 (28·6–50·4)	40·9 (29·7–51·4)	43·2 (31·3–54·1)	44·7 (33·1–54·8)	48·9	60·2	10·0	15·4
Eritrea	28·9 (24·4–33·9)	35·3 (29·8–41·2)	38·0 (29·2–47·1)	38·8 (27·6–49·5)	37·8 (26·4–48·5)	38·1 (25·6–49·9)	41·5	48·9*	12·7	10·9
Ethiopia	23·1 (19·1–28·2)	26·8 (22·8–31·5)	30·6 (26·3–35·8)	34·9 (30·9–39·6)	40·4 (34·3–47·0)	44·2 (35·2–52·6)	36·8	48·1*	13·7	3·9
Kenya	42·6 (39·3–45·6)	42·3 (39·1–45·7)	44·0 (40·7–47·4)	46·4 (43·1–49·6)	47·5 (44·3–50·6)	48·7 (45·2–52·2)	49·5	61·1	6·8	12·4
Madagascar	34·8 (31·0–38·7)	36·5 (32·6–43·3)	38·7 (34·1–47·3)	41·6 (36·5–49·4)	42·5 (35·5–50·3)	43·7 (34·9–53·1)	46·4	50·8*	11·6	7·1
Malawi	34·7 (29·9–39·6)	35·4 (28·8–42·4)	36·5 (29·1–43·1)	40·6 (34·1–46·8)	44·3 (37·8–50·5)	47·0 (38·4–55·1)	42·4	48·4*	7·7	1·4
Mozambique	33·2 (29·0–37·5)	35·1 (30·9–39·3)	36·4 (31·4–41·8)	39·6 (33·4–46·2)	40·9 (33·9–48·9)	43·0 (33·7–53·2)	31·5*	47·1*	..	4·1
Rwanda	29·9 (25·4–34·4)	23·3 (18·5–27·7)	30·4 (25·4–35·0)	42·6 (37·4–47·9)	47·0 (40·4–53·6)	47·8 (39·0–55·8)	43·3	51·0*	13·4	3·2
Somalia	29·1 (13·9–45·8)	29·3 (14·8–46·3)	30·1 (14·9–47·3)	31·8 (15·9–49·6)	33·3 (16·0–50·0)	34·2 (17·2–50·8)	35·5*	38·6*	6·4	4·4
South Sudan	33·4 (17·2–47·6)	34·7 (18·0–49·6)	37·5 (19·8–52·3)	39·0 (20·5–53·5)	38·8 (17·9–53·6)	38·8 (18·8–53·2)	38·0*	46·4*	4·6	7·6

(Table 3 continues on next page)

	HAQ Index (95% UI)						HAQ Index frontier		Difference between observed and frontier HAQ Index values	
	1990	1995	2000	2005	2010	2015	1990	2015	1990	2015
(Continued from previous page)										
Tanzania	39·9 (36·0–44·1)	41·0 (36·7–45·6)	43·1 (38·0–48·3)	46·7 (40·2–52·3)	48·8 (39·9–56·5)	49·9 (39·0–59·0)	47·0	54·6*	7·2	4·6
Uganda	34·0 (28·8–40·9)	33·9 (28·1–41·4)	35·2 (30·2–41·2)	38·2 (33·6–43·3)	41·4 (34·9–48·6)	42·9 (33·6–53·7)	43·2	51·3*	9·2	8·3
Zambia	37·4 (32·6–42·2)	34·6 (29·6–39·9)	34·3 (29·4–39·0)	35·5 (31·1–40·2)	37·4 (32·2–42·6)	41·6 (33·9–50·1)	49·0	60·7	11·6	19·2
Southern sub-Saharan Africa	44·8 (42·2–47·3)	46·7 (44·0–49·2)	43·4 (40·6–46·2)	43·1 (40·2–46·1)	46·3 (43·5–49·1)	49·2 (46·6–51·9)	65·3	74·8	20·5	25·6
Botswana	44·9 (27·6–58·1)	45·4 (24·3–59·3)	43·7 (20·5–59·4)	43·9 (21·8–60·3)	48·6 (26·0–62·5)	51·1 (28·0–63·6)	55·4*	73·9	10·5	22·9
Lesotho	40·8 (35·3–46·9)	41·8 (36·4–48·4)	39·4 (33·0–45·2)	33·2 (27·9–38·4)	34·4 (27·4–41·6)	35·7 (26·1–45·9)	49·1	65·1	8·4	29·3
Namibia	41·8 (38·1–45·6)	41·9 (37·9–45·7)	39·9 (34·6–45·2)	43·5 (37·3–49·2)	50·4 (43·8–57·3)	53·7 (44·7–61·5)	58·0	72·9	16·2	19·2
South Africa	45·6 (42·7–48·4)	47·9 (45·4–50·4)	44·8 (41·8–48·1)	45·2 (41·6–48·7)	49·4 (46·0–52·8)	52·0 (49·2–54·9)	69·7	77·1	24·1	25·1
Swaziland	41·5 (35·7–47·6)	45·7 (38·7–54·2)	40·7 (33·3–47·5)	35·1 (27·8–42·1)	37·8 (28·9–47·8)	41·9 (30·7–54·5)	55·0	73·3	13·5	31·4
Zimbabwe	48·1 (43·8–52·9)	49·5 (41·1–57·0)	45·4 (36·8–52·2)	41·8 (34·4–48·6)	42·1 (35·8–48·2)	48·7 (40·1–57·3)	56·0	66·6	7·9	17·9
Western sub-Saharan Africa	35·3 (31·3–39·3)	36·2 (33·1–39·4)	37·0 (34·3–40·2)	39·7 (36·9–42·7)	43·3 (40·2–46·3)	44·8 (40·9–48·1)	46·2	53·3	10·9	8·5
Benin	36·9 (32·9–41·2)	37·0 (32·8–41·3)	37·3 (32·7–42·2)	40·4 (34·5–46·5)	41·5 (33·0–49·9)	43·0 (32·8–52·9)	42·8	49·7*	5·9	6·7
Burkina Faso	32·9 (28·9–37·4)	34·1 (29·8–38·7)	36·0 (31·6–40·7)	40·3 (35·4–45·2)	42·7 (36·2–49·4)	42·9 (33·8–51·5)	33·1*	45·2*	0·2	2·3
Cameroon	38·3 (34·6–42·2)	37·7 (33·5–41·8)	37·2 (32·3–42·6)	41·0 (36·1–46·4)	42·5 (35·6–49·1)	44·4 (35·0–53·3)	48·9	60·4	10·6	16·0
Cape Verde	50·1 (47·4–52·6)	49·3 (45·3–53·2)	50·8 (45·5–56·2)	53·7 (49·2–58·4)	57·9 (55·6–60·3)	61·7 (58·1–64·9)	48·3*	67·6	..	5·8
Chad	35·6 (30·8–40·6)	35·2 (30·8–40·3)	32·1 (27·1–37·4)	34·1 (26·9–41·1)	36·3 (26·8–46·1)	37·7 (27·1–48·2)	38·1*	47·5*	2·5	9·8
Côte d'Ivoire	35·5 (31·4–39·4)	33·2 (28·5–38·3)	34·4 (29·2–39·7)	37·6 (32·4–42·5)	40·7 (34·2–47·2)	42·4 (33·7–50·8)	46·3	51·5	10·8	9·2
The Gambia	41·3 (32·1–50·4)	42·4 (35·2–49·7)	43·3 (38·6–48·2)	45·6 (41·6–50·1)	47·7 (43·2–52·5)	49·7 (43·1–56·3)	45·2*	49·0*	4·0	..
Ghana	34·8 (28·3–40·9)	38·5 (33·9–43·3)	40·3 (35·4–45·5)	44·2 (38·5–50·4)	47·3 (38·8–55·7)	49·7 (40·0–58·8)	49·8	64·2	15·0	14·6
Guinea	32·6 (28·6–36·9)	33·6 (29·6–37·9)	34·0 (30·1–38·3)	37·0 (32·6–41·5)	37·6 (32·6–43·0)	38·6 (30·7–46·6)	40·4	47·1	7·8	8·5
Guinea-Bissau	32·7 (15·3–46·7)	33·1 (14·7–47·3)	33·6 (15·7–48·2)	33·3 (14·9–48·3)	35·1 (16·2–49·1)	36·3 (15·0–50·2)	40·8*	47·8*	8·1	11·5
Liberia	34·7 (28·9–40·5)	37·1 (32·3–41·9)	39·5 (34·7–44·7)	41·7 (37·0–46·7)	43·2 (38·2–48·5)	45·4 (37·8–52·9)	43·9	47·3*	9·2	1·9
Mali	32·7 (28·8–37·0)	33·8 (29·9–37·9)	37·7 (33·7–42·0)	43·5 (39·2–47·8)	44·4 (39·2–49·9)	45·6 (38·1–53·2)	35·1*	44·8*	2·4	..
Mauritania	37·3 (33·3–41·4)	38·9 (34·8–43·5)	42·9 (38·5–47·8)	46·9 (42·1–52·7)	49·6 (43·5–55·4)	52·0 (43·8–60·3)	46·6	53·4*	9·2	1·4
Niger	31·8 (26·9–36·9)	33·1 (28·6–37·9)	34·6 (30·3–38·9)	37·7 (33·2–42·3)	40·3 (34·7–45·5)	41·0 (32·3–48·9)	32·6*	38·2*	0·8	..
Nigeria	38·3 (31·2–45·4)	39·7 (34·4–45·0)	40·6 (36·2–45·4)	43·1 (38·4–47·9)	48·8 (43·2–54·4)	51·3 (43·2–57·0)	48·2	61·4	9·9	10·1
São Tomé and Príncipe	41·3 (37·8–45·2)	41·9 (38·0–45·7)	42·8 (39·3–46·8)	44·0 (39·3–48·4)	47·3 (40·9–53·7)	49·6 (40·7–58·6)	48·1	58·8	6·8	9·2

(Table 3 continues on next page)

	HAQ Index (95% UI)						HAQ Index frontier		Difference between observed and frontier HAQ Index values	
	1990	1995	2000	2005	2010	2015	1990	2015	1990	2015
(Continued from previous page)										
Senegal	37·6 (33·3–41·8)	38·1 (34·0–42·2)	38·9 (34·8–43·0)	41·5 (35·7–47·1)	42·9 (34·4–51·2)	44·4 (34·0–54·3)	43·5	49·4*	6·0	4·9
Sierra Leone	37·6 (30·8–45·1)	37·2 (32·1–42·8)	35·4 (30·7–40·4)	36·1 (31·8–40·8)	38·2 (33·1–43·7)	41·3 (33·3–49·1)	41·3*	48·9*	3·6	7·6
Togo	37·4 (33·0–41·8)	36·9 (32·8–41·3)	36·9 (32·1–42·6)	40·1 (34·8–45·6)	41·8 (36·1–47·9)	44·3 (36·6–52·5)	45·5	50·3*	8·2	6·0

Geographies that exceed the HAQ Index frontier associated with their level of SDI have double dots in place of values in the columns representing the difference between observed and frontier HAQ Index levels. GBD=Global Burden of Disease. HAQ Index=Healthcare Access and Quality Index. SDI=Socio-demographic Index. UI=Uncertainty interval. *Geographies for which the HAQ Index frontier in 1990 or 2015 is within the 95% UIs of their observed HAQ Index values for those years.

Table 3: **Global, regional, and national or territory-level estimates of the HAQ Index for each 5-year interval from 1990 to 2015, frontier values in 1990 and 2015 on the basis of SDI, and the difference between observed HAQ Index and frontier values in 1990 and 2015**

rose (figure 4). Further, maximum HAQ Index levels achieved generally improved since 1990 across levels of SDI. Table 3 details each geography's HAQ Index values for 5-year intervals from 1990 to 2015, as well as their frontier HAQ Index levels on the basis of a location's SDI. Measuring the distance between a geography's observed HAQ Index in 1990 and 2015 and its frontier for these years provides a benchmark for potential gains in health-care access and quality—a metric that also considers the geography's relative resources on the basis of SDI. Additionally, comparing how differences between a given place's observed HAQ Index and frontier change over time can show where personal health-care access and quality have improved in parallel with changes in development.

Worldwide, the average HAQ Index values significantly increased, but the average global frontier improved in tandem; subsequently, gaps between the global HAQ Index and frontier changed minimally between 1990 and 2015. While most regions recorded narrowing gaps between average HAQ Index values and maximum levels achieved, a subset saw negligible progress or widening differences (eg, southern sub-Saharan Africa, south Asia, and the Middle East). In 2015, 52 countries and territories had HAQ Index estimates that included the frontier within their uncertainty bounds, indicating these geographies met the maximum levels of personal health-care access and quality attained by locations of similar SDI. Conversely, 62 geographies fell further behind the HAQ Index frontier associated with their level of SDI; this trend was especially pronounced in much of southern sub-Saharan Africa, Iraq, Pakistan, and Honduras (figure 5). This result was in stark contrast with several countries in eastern and western sub-Saharan Africa (eg, Burundi, Comoros, Rwanda), Turkey, Peru, and South Korea, many of which more than halved the differences between their HAQ Index and frontiers given their SDI by 2015.

Discussion

Drawing from GBD 2015, we constructed a novel measure of personal health-care access and quality—the HAQ Index—by using highly standardised estimates of 32 different causes that are amenable to personal health care. Compared with previous efforts, the HAQ Index provides a clearer signal on personal health-care access and quality over time and place because GBD provides enhanced comparability of cause of death data, helps to account for variation due to behavioural and environmental risk factors, and includes 195 countries and territories over time. Our analysis showed large differences in personal health-care access and quality, spanning from a low of 23·1 in Ethiopia in 1990 to higher than 90 in Andorra, Iceland, Switzerland, Norway, and Sweden in 2015. The global HAQ Index improved from 40·7 in 1990 to 53·7 in 2015, and 167 of 195 countries and territories significantly increased their HAQ Index during this time. Although the HAQ Index and SDI were highly correlated, we noted substantial heterogeneity for geographies at similar SDI. If every location reached the highest observed HAQ Index experienced by level of SDI, our global measure of health-care access and quality could have reached 73·8 in 2015—a clear indicator of untapped potential for health-care improvement worldwide.

While most countries saw progress on the HAQ Index since 1990, the marked improvements recorded for countries including South Korea, Turkey, and China highlight that much more rapid advances are possible. A subset of countries narrowed the gap between observed personal health-care access and quality and what could be expected given their level of development—and then achieved gains beyond what might be anticipated on the basis of SDI. Peru, the Maldives, and Ethiopia are examples of such stand-out geographies for reaching higher-than-expected levels of personal health care and access since 1990. Case studies conducted by the World Bank highlight potential drivers of these countries' successes,[60] and additional research on how certain

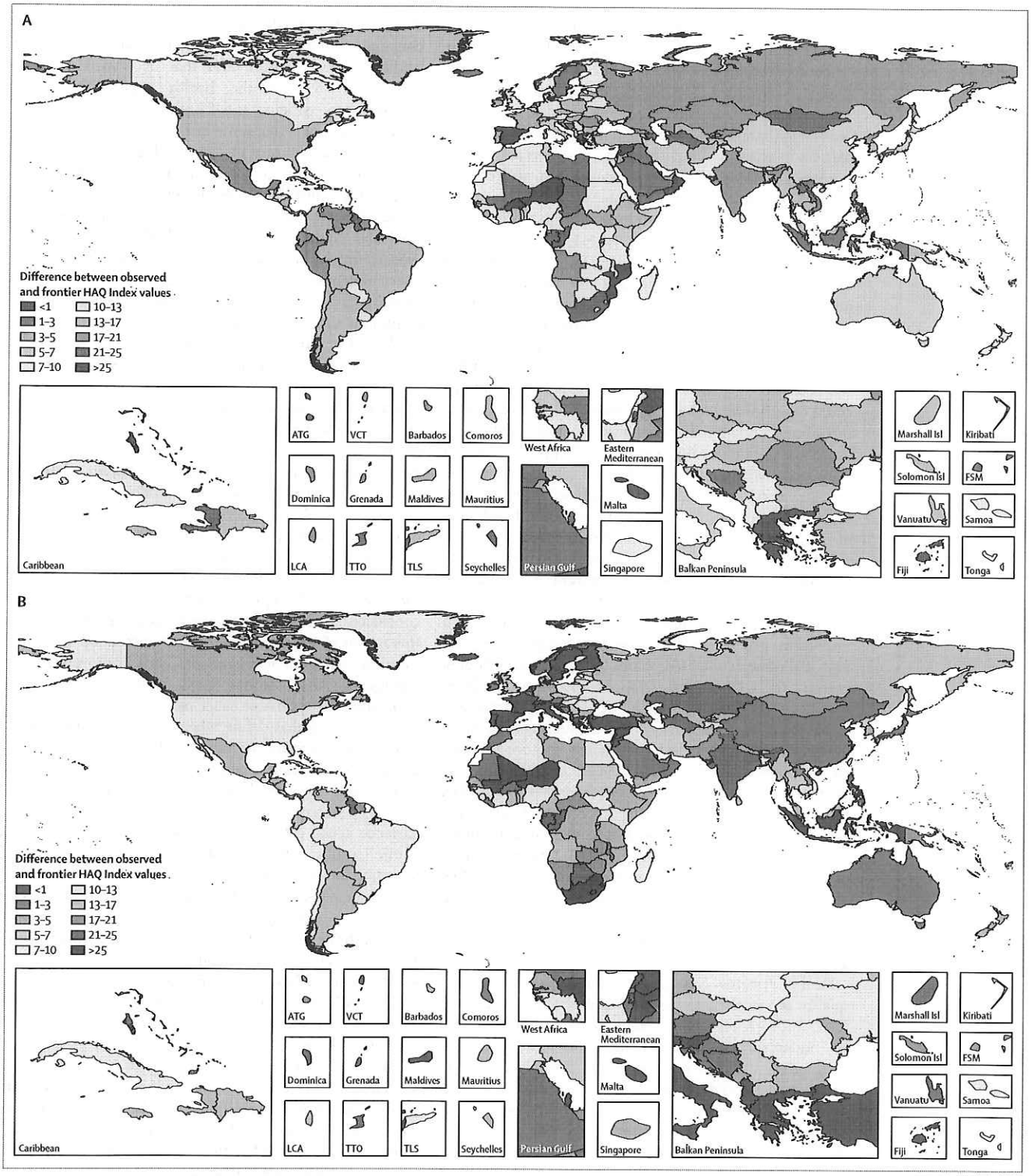

Figure 5: **Map of the gap between observed HAQ Index and frontier values in 1990 (A) and 2015 (B)**
Difference in observed HAQ Index and frontier values were the highest levels achieved by geographies of similar SDI in a given year. HAQ Index=Healthcare Access and Quality Index. SDI=Socio-demographic Index. ATG=Antigua and Barbuda. VCT=Saint Vincent and the Grenadines. LCA=Saint Lucia. TTO=Trinidad and Tobago. TLS=Timor-Leste. FSM=Federated States of Micronesia.

health-system attributes, including financing arrangements, provider ownership, and stewardship functions, are related to personal health-care access and quality is warranted. Separating out measures of access from quality of care received would be ideal, especially because programmatic and policy options to address barriers in access and quality can differ across and within countries. Nonetheless, such information measured in a consistent manner is rarely available.[34,46,57,60]

Several geographies had minimal gains in reducing the difference between their observed HAQ Index and the highest levels achieved at a similar SDI—a warning sign that heightened health-care access and quality is not an inevitable product of increased development. Further, a subset of countries in southern sub-Saharan Africa, south Asia, and the Middle East saw widening gaps between HAQ Index values in 2015 and the frontier reached by countries of comparable SDI. These findings could reflect several challenges faced by these countries, including subnational inequalities in both wealth and health-care options; and recent or rapid epidemiological transitions wherein the health-care sector and cause-specific services offered trail behind the diseases afflicting populations. Along with examining the drivers of greater-than-expected gains, future studies should strive to understand why other countries are lagging behind—and how they can pursue advancing health-care access and quality for all individuals.

Improving personal health-care access and quality is an important priority in the SDG era, emphasising the potential utility of the HAQ Index for SDG monitoring. At present, the UHC target—SDG 3.8—focuses mainly on so-called tracer interventions in the areas of maternal and child health, reproductive health, and a subset of infectious diseases,[61] and thus fails to adequately capture the vital role of personal health care for NCDs and injuries. The HAQ Index provides a more comprehensive measure that reflects health-system capacity for effectively detecting risk for, managing, and preventing early death from a range of conditions. Combining the HAQ Index, coverage of health interventions, and prevalence of risk factors that are modifiable through public health initiatives could provide a more robust mechanism for tracking UHC progress across multiple dimensions of health-system action.

Health systems can provide differential access and quality across therapeutic areas and levels of care. The HAQ Index reflects the average experience as captured by included conditions, and does not currently distinguish between diseases more strongly related to primary or secondary care. Our PCA weights suggest some conditions are less highly correlated with other causes, including colon cancer, breast cancer, testicular cancer, non-melanoma skin cancer, or diphtheria. The comparatively low weights on these outcomes could reflect measurement error, residual challenges in risk standardisation, or health-system heterogeneity by level of care. Subnational work that identifies variation in personal health-care access and quality within a particular health-system structure, and that uses multi-method approaches to view the health system from the perspective of patients and frontline providers,[62,63] may help elucidate whether some health-system components function distinctly from its average. For example, access to and quality of oncology care might be relatively distinct from other health-system dimensions and, where appropriate treatment is contingent on specialists or particular equipment, such as radiotherapy for cancer, even a temporary loss of these resources may substantially affect outcomes.[64] Conversely, access to high-quality primary care services, which enable early detection of conditions that are fatal if diagnosed at later stages, can be shaped by different factors, such as flexibility of clinic hours or types of insurance providers accepted.[65]

Mortality amenable to personal health care and mortality attributable to modifiable behavioural and environmental risk factors

For the present study, we based the HAQ Index on the list of causes established by Nolte and McKee,[4,9,11,30,31,35] and did not systematically re-examine scientific literature to update causes for which personal health care can significantly improve outcomes. Conducting this kind of systematic review is crucial to identifying additional causes for inclusion in the HAQ Index. Numerous causes should be considered, and would likely result in adding antiretroviral therapy for HIV, artemisinin-based combination therapies for malaria, treatment of hepatitis C, and improvements in emergency and trauma care, among others.[41,42,66–69] Expanding the amenable cause list should be determined by clear criteria that define when health care sufficiently reduces cause-specific mortality and thus provides a strong enough signal about access and quality. Such additions will probably improve the HAQ Index, though the nature of PCA estimation and its measurement of common variance across 32 causes may not substantially change future results. This analysis stemmed from existing scientific literature on mortality amenable to health care, but personal health care also can have profound effects on non-fatal health outcomes (eg, hip replacement for oesteoarthritis or surgery for cataracts). Future updates of the HAQ Index should consider incorporating measures of non-fatal conditions amenable to personal health care, which would then capture health-system capacity to deliver health gains through improved functional health status.

Understanding how much mortality or disease burden is avertable based on providing access to high-quality personal health care and modifying behavioural and environmental risks through public health initiatives is of high policy interest. GBD currently assesses mortality and burden attributable to a large set of risk factors, which supplies useful insights on the potential of risk modification to improve health. Quantification of the full potential of personal health care to reduce burden

by cause would provide an important additional piece of policy-relevant information. Controlling for other factors through statistical modelling, such as income and educational attainment, we could examine how much cause-specific variation relates to the HAQ Index. Such work would help to pinpoint opportunities for national and subnational progress through health-system improvements, which would likely include public health programmes and policies as well as the organisation and delivery of personal health services across levels of care.

Moving to performance measurement

In estimating the HAQ Index frontier by SDI,[58] we quantified the gap between observed personal health-care access and quality and levels potentially achievable at a given level of SDI. With these analyses, we lay the foundation for a refined assessment of health-system performance. The World Health Report 2000, which sought to evaluate health-system performance by country,[70] estimated the contribution of health systems for improving healthy life expectancy while statistically controlling for other factors. As suggested by Nolte and McKee,[9,71] using a measure more directly related to health-system actions, such as mortality amenable to personal health care, could reduce the need to control for other factors in health-system performance assessment. The World Health Report 2000 framework used five broad dimensions—average levels of health, inequalities in health, average levels of health-system performance, inequalities in responsiveness, and fair financing—and then compared overall health system attainment based on a frontier for health expenditure per capita.[71] Our current analysis only focused on the contribution of personal health care to mortality and the potential for improvement in this domain relative to development. In the future, GBD could support examining subnational health inequalities and expanding into health finance quantification of financial risk protection. A stronger empirical basis for assessing these three domains of health-system performance would also facilitate testing a range of efficiency and performance models.

Our frontier analysis showed that the highest observed HAQ Index levels, as achieved by geographies with an SDI of 0·8 or higher, steadily shifted higher over time. This expansion of health-care access and quality may reflect a rising share of GDP allocated to health among high-SDI countries. However, the frontier estimate for GDP per capita spent on health points to a similar shift upward at high expenditure. One explanation of this trend is new medical technologies and programmes, which could be driving an overall upward shift in health-care access and quality achievable in well financed systems. Another potential explanation is innovation in health-care organisation, such as the creation of centralised stroke care units in major cities.[72] A more detailed examination of these changes may further elucidate how investing in medical innovations can affect health-system performance. In particular, this might shed light on the association between investment in health-care resources and outcomes, a relationship that is unlikely to be linear. For instance, audits have identified three main factors underlying maternal deaths: substandard care, delays in care, and problems with blood transfusions.[73] Addressing the latter requires a different type of intervention, namely investments in infrastructure, than the former two factors. Such knowledge is of particular importance in the SDG era, as some studies point to advances in medical technology and innovation as the primary pathway for elevating health alongside increasing development.[74]

HAQ Index compared to other measures of access and quality of care

Detailed results on HAQ Index components seem consistent with previous, albeit limited, studies on health-care performance. Within Europe, Nordic countries performed especially well, corresponding with past work on a composite measure of public health policies.[75] Country performance on diabetes aligned with earlier work on diabetes mortality and incidence,[25] wherein country-level differences were largely explained by known health-system changes, such as substantial improvements in several Baltic states during the late 1990s. In Latin America, Costa Rica's relatively high HAQ Index (72·9), as compared with nearby countries (eg, Nicaragua [64·3], Guatemala [55·7]), is consistent with its designation as an original "good health at low cost" country.[76]

In view of the paucity of standard health-care access and quality measures, assessing HAQ Index validity compared to other indicators was challenging. In this analysis, we identified three measures of health-system resources and three measures of intervention coverage that included at least 70 countries. These correlations, which all exceeded 0·60, offer some evidence of convergent validity but do not provide criterion validity.[77,78] Nonetheless, these results are encouraging and stand in contrast to previous studies done in limited settings.[37–40] In comparison with past work,[9,11,31] the moderately high correlation with other health-care indicators might be due to our efforts to risk-standardise mortality amenable to health care; PCA weighting of different amenable conditions; and the inclusion of a substantively larger, more diverse set of health systems across the development spectrum. Additional validation analyses are needed to compare HAQ Index performance with other measures of health-care access and quality; such validation exercises might be more feasible at the subnational level with greater data density, such as states in the USA.[79]

Limitations

This analysis has a number of limitations beyond those already described. First, many limitations experienced in GBD cause of death estimation are applicable to this study.[47] Second, our risk-standardisation procedure might not represent all possible risk-outcome pairs as they

pertain to included causes of amenable mortality (eg, determinants of testicular cancer or neonatal disorders).[48] With its annual updates, GBD aims to improve upon its comparative risk assessment, and thus HAQ Index assessment is likely to be improved alongside advances in risk quantification. Third, two causes received negative weights in the PCA analysis and were subsequently excluded. One potential explanation for this is that joint PAFs for these causes may underestimate risk-attributable mortality in high-SDI countries (eg, the effects of diet, obesity, and physical inactivity for breast cancer). However, given the high Spearman's rank order correlation between the average of all 32 causes and the HAQ Index, excluding these causes from the PCA likely had minimal effect on our results. Fourth, we used PCA to construct the HAQ Index based on age-standardised risk-standardised death rates from the 32 causes. Alternative methods for index construction led to highly correlated results, but exact rankings somewhat varied. We subsequently view exact rank orders as less useful than comparing a given geography's HAQ Index values over time, to countries of similar SDI, and relative to the HAQ Index frontier. Fifth, while the HAQ Index offers a more robust indicator of overall health-care access and quality than currently available measures, it does not directly capture effects of personal health care on causes without substantial mortality (eg, depression, hip oesteoarthritis, and cataracts). The effects of health care on both fatal and non-fatal conditions may be highly correlated, but incorporating how access and quality of care explicitly affect non-fatal outcomes would improve measurement. Sixth, GBD corrections for cause of death misclassifications (so-called garbage codes) varies substantially by geography and thus can affect results. Even among high-SDI countries, GBD showed substantial variation for the proportion of amenable deaths assigned to garbage codes, ranging from 7·9% in Finland to 39·8% in Portugal (appendix p 19). Seventh, for countries with complete or nearly complete vital registration (VR) data and few deaths misclassified based on ICD codes, the HAQ Index may be more robust and less prone to high levels of uncertainty than for countries with lower-quality or non-existent VR data. Mortality estimates that heavily draw from verbal autopsy data or other modelling approaches have larger UIs. Our results for most of sub-Saharan Africa, for example, include wide UIs and thus few countries recorded HAQ Index values that statistically differed from the regional mean. Eighth, we rescale the log age-standardised risk-standardised death rate for each cause from 0 to 100 using the observed range across countries from 1990 to 2015, but achieving 100 does not mean that additional improvement is not possible. Subsequently, the HAQ Index range reported here is relative to national achievements to date, and these thresholds may rise if or when improved personal health-care access and quality occurs for given causes. Ninth, the HAQ Index does not currently capture subnational inequalities in personal health-care access and quality, which might emerge on the basis of geographic location or socioeconomic status, among other factors. Future efforts to quantify these measures with greater geospatial resolution should be prioritised.

Conclusions

Our analysis demonstrates that a policy-relevant summary measure of personal health-care access and quality can be derived from GBD. This novel measure supports the first-ever comparable assessment of personal health-care access and quality across 195 countries and territories, over time, and along the development spectrum. The HAQ Index considerably advances previous efforts to approximate personal health-care access and quality by systematically adjusting for cause of death certification biases and misclassification, risk-standardising death rates across geographies, and applying PCA to identify common dimensions of health-care access and quality associated with multiple conditions. Globally, most countries and territories recorded gains in personal health-care access and quality from 1990 to 2015, yet many still experienced levels that fell well below what has been achieved by geographies at a similar development status. Amid calls to improve monitoring of UHC and overall health-system performance, the HAQ Index provides a strong basis for benchmarking progress toward greater access and higher-quality personal health care alongside country-level gains in resources to achieve these aims.

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