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Incorporating Equity–Efficiency Interactions in Cost-Effectiveness Analysis—Three Approaches Applied to Breast Cancer Control

Stefan A. Baeten, MSc,[1] Rob M. P. M. Baltussen, PhD,[2] Carin A. Uyl-de Groot, PhD,[1] John Bridges, PhD,[3] Louis W. Niessen, MD, PhD[1,3,4]

[1]Institutes of Health Policy & Management and of Medical Technology Assessment, Erasmus Medical Centre, Rotterdam, The Netherlands; [2]Department of Public Health, Radboud University, Nijmegen, The Netherlands; [3]Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA; [4]School of Medicine, Policy, and Practice, University of East Anglia, Norwich, UK

ABSTRACT

Background: The past decade, medical technology assessment focused on cost-effectiveness analysis, yet there is an increasing need to consider equity implications of health interventions as well. This article addresses three equity–efficiency trade-off methods proposed in the literature. Moreover, it demonstrates their impact on cost-effectiveness analyses in current breast cancer control options for women of different age groups.
Methods: We adapted an existing breast cancer model to estimate cost-effectiveness and equity effects of breast cancer interventions. We applied three methods to quantify the equity–efficiency trade-offs: 1) targeting specific groups, comparing disparities at baseline and in different intervention scenarios; 2) equity weighting, valuing low and high health gains differently; and 3) multicriteria decision analysis, weighing multiple equity and efficiency criteria. We compared the resulting composite league tables of all approaches.
Results: The approaches show that a comprehensive breast cancer program, including screening, for women below 75 years of age was most attractive in both the group targeting approach and the equity weighting approach. Such control programs would reduce disparities with 56% and at €1908 per equity quality-adjusted life-year gained. In the multicriteria approach, a comprehensive treatment program for women below 75 years of age and treatment in stage III breast cancer were most attractive, with both an 82% selection probability, followed by screening programs for the two age groups.
Conclusion: In the three equity weighing approaches, targeting women below 75 years of age was more cost-effective and led to more equitable distributions of health. This likely is similar in other fatal diseases with similar age distributions. The approaches may lead to different outcomes in nonfatal disease.
Keywords: breast cancer, equity–efficiency trade-off, health economics methods, Markov model.

Introduction

The distribution of the disease burden [1,2] and treatment benefits [3,4] are frequently an area of health economics research. In breast cancer, control studies reveal differences in disease burden by race [2], urbanization [5], socioeconomic status [6], and insurance status [7]. These studies typically report disparities in incidence, prevalence, stage distribution, and disease mortality. In some studies, differences in quality-adjusted life expectancy are calculated [8]. One may distinguish three ways of equity reporting [9].

First, one may observe differences in health outcomes, such as life expectancy, quality of life, and incidence of a condition. Second, disparities may be reported in the provision of health care with those with a more severe condition receiving less, i.e., vertical equity. Third, inequities may be related to dissimilar use of health care for individuals with the same health, i.e., horizontal equity [9]. These three types of equity are interrelated, as utilization of health care is related to health outcomes, and both are related to difference in access. In all cases, inequalities may be reduced through the provision of additional health care to underprivileged groups, for example, by differential reimbursement of health packages [10].

Address correspondence to: Louis W. Niessen, Department of International Health, Johns Hopkins School of Public Health, 615 N Wolfe Street, Suite E8136, Baltimore, MD 21206, USA. E-mail: lniessen@jhsph.edu
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Descriptive and distinct information about health disparities and cost-effectiveness estimates in relation to health interventions may be available and may give insight. Yet, due to the descriptive nature, its use in health policy, addressing equity and efficiency, is limited. Such a broad approach to evidence-based priority setting in health programming would use efficiency information on available strategies, as well as their potential for reducing existing disparities. Without this, reduction of inequalities as a policy goal remains a matter of intuition and debate, rather than of systematic evaluation. If so, still, interventions may have differential effects on the distribution of health depending on the way health inequalities are actually defined, measured, and addressed.

Methodological studies on the use of equity considerations in cost-effectiveness analysis and its effect on health inequalities are reported [11–15]. Nevertheless, comparisons of the impact of these methods in economic evaluation have, so far, not been done, and any application in breast cancer control is absent. We distinguished three different methods that can be potentially beneficial in priority setting: targeting specific groups, equity weighting [13], and multicriteria decision analysis [11,16].

The aim of the article is to show the potential and the impact of these approaches in the use of cost-effectiveness analysis, e.g., by government agencies responsible for the selection of health benefit packages. Such processes may have yet to become more explicit, transparent, and thorough if equity implications are to be considered similarly as and parallel to cost-effectiveness analyses. Our perspective is societal and governmental, given the nature of any operational equity–efficiency approach.

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We explain three approaches in the method section and relate them to the underlying theory. Subsequently, we demonstrate their application in cost-effectiveness analyses, aiming at a rank order of optional interventions. We apply the equity-incorporating approaches for breast cancer control evaluations using an existing breast cancer life table model [17], addressing the existing controversy in breast cancer control options by age groups. Differentiating breast cancer control options by age is subject to debate [18–20].

Methods

We first describe three equitability approaches; subsequently, we summarize the use and application of the existing World Health Organization (WHO) breast cancer model and the combined equity and cost-effectiveness analysis.

Equity Approaches

Targeting specific groups. The first method we identified for the integration of distributive and economical impact of health interventions is simply targeting specific groups. This method shows how disparities between groups in breast cancer burden can be reduced through interventions in specific population subgroups, e.g., on the basis of insurance status [21]. The first step in the analysis is identical to the measurement of systematic differences by subgroups, usually defined by an indicator of social economic status. The second step involves selecting an intervention which addresses the difference between those specific subgroups. This means that it is necessary to determine what causes these differences in the first place and in which way they can best be diminished. One or more scenarios can then be constructed in which the targeted group of patients receives the intervention and the remaining group receives the usual level of care. The analyses show the potential improvement in health outcomes of groups of patients both in absolute (increase in health) and relative (reduction of inequalities) terms.

Equity weighing. Equity weighting [13] is based on the concept of the rank-dependent quality-adjusted life-year (QALY) model [12]. This method aggregates QALY gains from health interventions over a person's lifetime. In traditional health utility analyses, aggregation is straightforward, assigning equal valuation to each QALY gained. Nevertheless, policymakers may want to discriminate between various subgroups when choosing health interventions and may want to give more weight to health gains achieved in relative worse-off groups. Equity weighting quantifies these preferences by assessing the rank of the beneficiaries in the distribution of health. In this approach, the valuation of QALYs is nonlinear, which makes it possible to assign extra weight to the worst-off. The social value of a QALY profile (i.e., the distribution of health) is then given by:

$$\sum_{i=1}^{n} \pi_i U(q_i), \qquad (1)$$

where π_i is the weight given to the QALY score q for individual i. The nonlinearity is shown by the function $U(q_i)$ instead of q_i. In this approach, the objective is to maximize Equation 1 instead of health as described in Equation 2 [13]:

$$\sum_{i=1}^{n} q_i \qquad (2)$$

We assess the values of q_i in different scenarios and compare results with and without equity weighting, using both Equations 1 and 2. We use values of equity weights from the Dutch setting [13].

Multicriteria decision analysis. Multicriteria decision analysis reflects societal preferences for a number of characteristics of health programs in addition to cost-effectiveness, such as severity of the disease and the average age of the targeted population [11]. The full set of criteria [16,22,23] describes the most important aspects of a health intervention. The preferences of society are then measured through a conjoint analysis. First, respondents are simultaneously presented with two health interventions described by the full set of criteria, i.e., a profile. From these two interventions, they are asked to pick the most attractive one. A statistical analysis is then used to determine the relative importance of each criterion, reflected by a beta coefficient. Using these coefficients, the attractiveness of every intervention described by the full set of criteria can be calculated. The attractiveness of each profile is measured as the probability of selection. Using the probability of selection, different interventions can be ranked in a composite league table.

We will use criteria and coefficients from multicriteria investigation among Health Technology Assessment (HTA) policymakers [23]. The general regression equation is:

$$P = \frac{EXP\left(\beta_0 + \sum_{k=1}^{8} \beta_k \times X_k\right)}{1 + EXP\left(\beta_0 + \sum_{k=1}^{8} \beta_k \times X_k\right)}, \qquad (3)$$

where β_0 is a constant, k indicates one of the eight dummy variables (i.e., six criteria of which two have three levels instead of two), and X_k indicates the score of the scenario on the dummy variable (i.e., either 0 or 1).

As discussed above, all three approaches deal with costs, effects, and equity in a different way. Some approaches describe equity implications more thoroughly than others. Although some use all cost-effectiveness data, others limit themselves in that regard. Yet all of them ultimately have the same goal: providing an informed equity–efficiency trade-off by ordering health interventions in a composite league table. Table 1 summarizes the way the three approaches incorporate the different aspects of health interventions. For illustrative purposes, a characterization of traditional health technology assessment is given as well.

Breast Cancer Model

We adapted an existing, standardized WHO method to arrive at comparative estimates in a broad cost-effective analysis to a multitude of interventions that is now under the name of the Choosing Interventions That Are Cost-Effective (CHOICE) program [27]. The existing breast cancer model based on this method [17] was adapted in such a way that it is suitable to incorporate the three equity approaches. The breast cancer model distinguishes four breast cancer stages defined according to the guideline definitions of the American Joint Committee on Cancer [24]. Breast cancer stages discern with regard to incidence, prevalence, case–fatality ratio, and health state valuation. We used age-specific epidemiological data for the European region from the Global Burden of Disease Studies [25]. Using age-adjusted data by breast cancer stage [17], we computed age and stage-specific prevalence, incidence, and mortality rates to estimate survival by disease stage. The age-adjusted estimates are provided in Table 2.

Cost estimates were also derived from the original study by Groot et al. We updated the cost prices to reflect 2007 prices by

Table 1 Outline of the three approaches including equity in cost-effectiveness analysis

Approach	Costs	Effect	Equity implication	League table based on
Traditional cost-effectiveness analysis	Included	Difference in health-adjusted life-years	Not applied	ICER
Group-targeted intervention	Not considered	Difference in DALE by age group per scenario	Absolute and relative reduction of health disparities between groups	Percentage reduction group differences
Equity weighting	Included	Equity weights times delta health years (i.e., EQALY)	Health benefits weighted higher for diseases with larger impact on lifetime health	E-ICER
Multicriteria decision analysis	Cost and effects categorized as attributes		Equity concept is captured in three attributes	Probability of selection

DALE, disability-adjusted life expectancy; (E-)ICER, (equity-adjusted) incremental cost-effectiveness ratio; (E)QALY, (equity and) quality-adjusted life-year.

using a price index of 116.3 (2000 = 100) [26]. We included patient costs based on treatment, follow-up, diagnostic workup of healthy women, screening, and false positive cases. Table 2 lists the associated cost. Furthermore, we assumed equal access to care and equal effectiveness of care for each age group in the existing situation.

First, we constructed a baseline, counterfactual scenario for all patients, irrespective of breast cancer stage or age, in the absence of treatment [17,27]. In the intervention scenarios, we implemented different sets of treatment in which the stage-specific case–fatalities and/or distribution of incident breast cancer cases were improved for either of the two age groups. The effects of the intervention scenarios were calculated over a standard time period for the whole of the breast cancer population. The intervention scenarios also differed with respect to which patient groups were treated, defined by the stage of breast cancer and age. The groups were analyzed separately, and are women aged 75 or less and those over 75. In summary, we assessed 12 scenarios: six interventions (the treatment of individual breast cancer stages I, II, III, or IV; the treatment of all stages; the treatment of all stages plus mammography screening) for two groups of women separately, i.e., those below 75 years of age and those of 75 years and over.

We first applied these scenarios in the simple reporting approach to demonstrate the potential for diminishing health inequalities between the two age groups. Second, we used equity weighting to revalue the gains of interventions in the two groups. Third, we applied multicriteria decision analysis to breast cancer treatment and screening for the different age groups. Each approach provided a different league table of the investigated health interventions that consider different breast cancer interventions and target groups.

Combined Equity and Efficiency Analysis

Targeting specific groups. We applied the breast cancer model to the EuroA zone of the WHO Global Burden of Disease Regions, commonly used for WHO CHOICE analyses. Analyses were performed separately for women below 75 years and those 75 years and over. As prevalent cases are inherently untreated at t = 0 and are more numerous in the higher age group, we only include incident cases. We calculated outcomes for both age groups without any treatment. To ensure all health benefits were included, the time horizon was 100 years. To correct for the women's lower life expectancy in higher age groups, we also included past life-years, which were assumed to be spent in good health.

In the base-case scenario, we calculated the average unadjusted and QALYs, and determined the initial health disparity between both groups. Subsequently, we introduced the six interventions one by one for each group separately and monitored the changes in health disparities. In other words, in each step and for each combination of interventions, we computed the difference in health between women below 75 years and those 75 and over.

Equity weighing. Equity preference weights were derived from preferences of the general population of The Netherlands by Bleichrodt et al. [13]. The weights were differentiated by age and

Table 2 Breast cancer model inputs

	Stage I	Stage II	Stage III	Stage IV	All
Disease data					
Stage distribution at diagnosis					
Without screening	0.09440	0.14170	0.57970	0.18420	
With screening	0.49000	0.37440	0.08610	0.04950	
Stage-specific mortality					
Without treatment	0.02000	0.06286	0.15000	0.30000	
With treatment	0.00638	0.04266	0.09336	0.27500	
Background mortality					0.0102
Prevalence rate					0.0081
Incidence rate					0.0011
Female population					8,002,084
Costs (€)					
Treatment	6,292	6,292	7,066	3,387	
Diagnosis					
Breast cancer patient					361
Healthy woman					86
Follow-up years 1–5					154
Follow-up years 6–10					111
Mammography					43
False positive screening					
Diagnosis					85
Biopsy					50

Table 3 Health gap and changes in health when targeting two age groups

			Stage treatment of women over 75 years						
			None	Stage I	Stage II	Stage III	Stage IV	All stages	All stages plus screening
Stage treatment of women under 75 years	None	QALY gap	**−4.87**	−4.91	−4.93	−5.23	−4.89	−5.36	−6.54
		Absolute reduction	**0.00**	0.04	0.06	0.36	0.02	0.49	1.68
		Relative reduction (%)	**0.0**	−0.9	−1.3	−7.5	−0.5	−10.1	−34.5
	Stage I	QALY gap	−4.83	−4.88	−4.89	−5.20	−4.86	−5.32	−6.51
		Absolute reduction	−0.03	0.01	0.03	0.33	−0.01	0.46	1.64
		Relative reduction (%)	0.7	−0.2	−0.6	−6.8	0.2	−9.4	−33.8
	Stage II	QALY gap	−4.81	−4.85	−4.87	−5.17	−4.83	−5.30	−6.49
		Absolute reduction	−0.06	−0.01	0.00	0.31	−0.03	0.43	1.62
		Relative reduction (%)	1.2	0.3	−0.1	−6.3	0.7	−8.9	−33.3
	Stage III	QALY gap	−4.44	−4.49	−4.50	−4.81	−4.47	−4.93	−6.12
		Absolute reduction	−0.42	−0.38	−0.36	−0.06	−0.40	0.07	1.25
		Relative reduction (%)	8.7	7.8	7.4	1.3	8.3	−1.4	−25.8
	Stage IV	QALY gap	−4.82	−4.87	−4.88	−5.19	−4.85	−5.31	−6.50
		Absolute reduction	−0.04	0.00	0.02	0.32	−0.02	0.45	1.63
		Relative reduction (%)	0.9	0.0	−0.4	−6.6	0.4	−9.2	−33.6
	All stages	QALY gap	−4.31	−4.35	−4.37	−4.67	−4.33	−4.80	−5.98
		Absolute reduction	−0.56	−0.52	−0.50	−0.20	−0.54	−0.07	−1.12
		Relative reduction (%)	11.5	10.6	10.2	4.0	11.0	1.4	−23.0
	All stages plus screening	QALY gap	−2.13	−2.18	−2.20	−2.50	−2.16	−2.63	−3.81
		Absolute reduction	−2.73	−2.69	−2.67	−2.37	−2.71	−2.24	−1.06
		Relative reduction (%)	56.2	55.3	54.9	48.7	55.7	46.1	21.7

A negative reduction indicates an increase in health gap. Bold type indicates baseline values without interventions.
QALY, quality-adjusted life-year.

stage of breast cancer at onset. Health effects were first calculated as the number of unweighted health years gained per treated woman and subsequently weighted, applying the weights found in the Bleichrodt et al. study. These weighted health years are the multiplication of the total health effect for breast cancer patients at a certain age with the corresponding equity weight. We refer to this result as equity and QALY (EQALYs).

Multicriteria decision analysis. In the multicriteria approach, we valued health interventions using the different characteristics of the interventions and the patient groups they are intended for. An index of the characteristics of the breast cancer intervention is used, from published discrete choice experiments [22]. We characterized the breast cancer interventions according to the descriptive criteria used: severity of disease, number of potential beneficiaries, age of target group, individual health benefits, poverty reduction, and cost-effectiveness. All of these variables have either two or three ordinal levels. The coefficients for the levels of the attributes were derived from a study with North American policymakers and HTA experts [23,28]. Through application of the coefficients for the indexed levels for each intervention in Equation 3, an overall probability was calculated, reflecting the relative attractiveness of the scenario.

Comparing our findings, we compared all 12 scenarios (six interventions for two different groups) for all three approaches in a new, composite league table in which the rank order was determined by the different outcome measures in each equity approach. Hence, the ranking resulting from the traditional cost-effectiveness analysis was determined by the cost-effectiveness ratios (CERs); the group targeting ranking depended on the relative reduction in the health gap (largest reduction preferred); the CER based on EQALYs was used to rank the scenarios in the equity weighting approach; and the probability of selection was used to order the results of the multicriteria decision analysis.

Results

In Table 3, the effects of breast cancer intervention on the disparities between the two age groups are presented. In the initial situation, without any breast cancer treatment for either group, the higher age group lives 4.87 lifetime QALYs longer (i.e., the difference in past and future health). Treating the group of breast cancer patients below 75 years of age reduces disparities with a maximum of 56% (screening and treatment of all breast cancer stages); treating the group of women over 80 years of age would increase the difference between the groups up to 6.55 lifetime QALYs, which is an increase of 34.5%.

The results per patient of both the traditional cost-effectiveness analysis and the cost-effectiveness analysis with equity weighting are presented in Table 4. The largest costs and

Table 4 Results of usual cost-effectiveness analysis and equity-weighted cost-effectiveness analysis

			Effects				Cost-effectiveness ratio			
	Costs (€)		Normal		Equity weighted		Normal		Equity weighted	
Treatment	75−	75+	75−	75+	75−	75+	75−	75+	75−	75+
Stage I	10,130	9,672	1.570	0.376	1.925	0.286	6,454	25,754	5,264	33,862
Stage II	10,044	9,570	1.556	0.370	2.016	0.285	6,456	25,889	4,982	33,564
Stage III	10,777	10,305	2.388	0.556	3.325	0.439	4,513	18,537	3,242	23,498
Stage IV	6,250	5,839	0.389	0.084	0.594	0.069	16,054	69,688	10,529	84,455
All stages	9,779	9,320	1.825	0.426	2.505	0.334	5,358	21,895	3,905	27,867
All stages and screening	16,788	17,006	6.896	1.445	8.801	1.126	2,435	11,766	1,908	15,105

effects (both QALYs and EQALYs) are associated with the scenario that includes screening and treatment of all breast cancer stages. The screening and treatment of women below 75 years is the most cost-effective scenario in both the traditional and equity weighting approach. The costs associated with the scenarios differ less than €500 between the two groups of women, but the difference in effects are relatively large in favor of women below 75 years.

In Table 5, all 12 scenarios are characterized using the set of attributes as described by Baltussen and Niessen [11], and applied to breast cancer treatment options. The resulting probabilities of selection of each treatment option are given in the bottom row. The most probable interventions for selection are the treatment of stage III or the treatment of all stages for women under the age of 75 ($P = 0.821$), and the least probable is the exclusive treatment of stage I breast cancer for elderly women ($P = 0.199$). Adding screening in control packages in the two age groups follows closely. The probabilities also show that selecting treatment interventions aimed at the group of women below 75 years of age are considered to be more attractive than those that are aimed at those of 75 and higher, for equity reasons.

Table 6 summarizes the results of the different interventions in separate composite league tables. Treating women aged below 75 years of age is more attractive than treating women over 75 years of age in all three approaches. In addition, all approaches except the multicriteria decision analysis rank the extensive program (i.e., screening with all types treatment) as most attractive.

Discussion

Interventions aimed at women less than 75 years of age rank higher in all of the equity-including approaches. Treatment scenarios for women of 75 and over lead to larger health disparities between the two age groups; have lower equity-adjusted CERs; and are less likely to have a high probability of selection in applying multiple criteria.

The results of the target group approach can be explained by the relative high average loss of healthy life-years at breast cancer diagnoses among ages below 75 in the base-case scenario (i.e., no treatment for either group). Women that received a diagnosis of breast cancer aged 80 already have lived 10 more years in good health than women that received a diagnosis at age 70. Therefore, any intervention aimed at the disadvantaged group (i.e., women of lower ages with breast cancer) in the calculation will result in positive effects on the distribution of health outcomes across all ages.

The use of equity weights further increases the attractiveness of treating women below 75 years of age and those of 75 and over, as compared with the regular efficiency approach. This is because equity weights are higher for women below 75 years than for women with higher ages, due to the differences in years lived in good health and the remaining potential life span.

The multicriteria decision analysis shows that having a disease at a lower age is an important criterion. There are other contributing factors as the number of potential beneficiaries is higher, the cost-efficiency ratio is lower, and the net individual health benefits are higher in this age group. Hence, interventions aimed at women below the age of 75 are more likely to be on the top of the league table.

Although we adapted the model distinguishing different breast cancer stages, there are constraints using the present breast cancer model [17]. Yet we did not incorporate implementation costs. This may vary by group. In addition, the input data used for the analysis (i.e., the epidemiological data, equity weights,

Table 5 Input values for the attributes of breast cancer treatment, by stage, and probability of selection in multicriteria decision analyses

	Stage treatment											
	Stage I		Stage II		Stage III		Stage IV		All stages		Screening + all stages	
Attribute	75–	75+	75–	75+	75–	75+	75–	75+	75–	75+	75–	75+
Severity of disease	Not severe		Not severe		Severe		Severe		Severe		Not severe	
Number of potential beneficiaries	Few	Few	Many	Few	Many	Many	Few	Few	Many	Many	Many	Many
Age of target group	Middle age	Elderly	Middle age	Elderly	Middle age	Elderly	Middle age	Elderly	Middle age	Elderly	Middle age	Elderly
Individual health benefits	Large	Small	Large	Small	Large	Small	Small	Small	Large	Small	Large	Large
Vulnerable groups focus	Neutral		Neutral		Neutral		Neutral		Neutral		Neutral	
Cost-effectiveness	CE	CE	CE	CE	CE	CE	CE	Not CE	CE	CE	CE	CE
Probability of selection	0.52	0.51	0.69	0.51	0.82	0.68	0.59	0.20	0.82	0.68	0.69	0.77

CE, cost-effective.

Table 6 League tables for breast cancer interventions in two age groups, for three different equity approaches

Scenario	Usual approach		Targeted intervention		Equity weighting		Multicriteria decision analysis	
	Rank	ICER	Rank	Relative gap reduction (%)	Rank	E-ICER	Rank	Selection probability
Stage I for women under 75	4	6,454	6	1	5	5,264	9	0.52
Stage II for women under 75	5	6,456	4	1	4	4,982	4	0.689
Stage III for women under 75	2	4,513	3	9	2	3,242	1	0.82
Stage IV for women under 75	7	16,054	5	1	6	10,529	8	0.59
All stages for women under 75	3	5,358	2	12	13	3,905	1	0.82
All stages and screening for women under 75	1	2,435	1	56	1	1,908	4	0.69
Stage I for women over 75	10	25,754	8	−1	11	33,862	10	0.51
Stage II for women over 75	11	25,889	9	−1	10	33,564	10	0.51
Stage III for women over 75	8	18,537	10	−7	8	23,498	6	0.68
Stage IV for women over 75	12	69,688	7	0	12	84,455	12	0.20
All stages for women over 75	9	21,895	11	−10	9	27,867	6	0.68
All stages and screening for women over 75	6	11,766	12	−34	7	15,105	3	0.77

Lowest rank number indicates highest priority.
(E-)ICER, (equity-adjusted) incremental cost-effectiveness ratio.

and the coefficients in the multicriteria decision analysis) were not all gathered in a similar setting. Consequently, the measured equity impact does not reflect true distributional preferences for a single assessed population. For these reasons, our results should be used with caution. Nevertheless, the significance of this research does not depend on the exact numbers and position in the league tables for the selected interventions. Testing and comparing the potential and its order of magnitude of the three existing equity–efficiency trade-off applications in health technology assessment is the main thrust of our article.

Nevertheless, we consider the preference of targeting women in lower age group as rather robust in the case of breast cancer control. The methods applied in this area do not result in large differences between them. Research that addresses interventions for different diseases, among more heterogeneous groups, and distributed differently across age groups, may not show similar patterns and cross-consistency among the three new league tables. This could potentially make the selection of a single equity–efficiency trade-off approach a delicate matter.

We defined equity in health in terms of changes of health outcomes given a particular condition and not in terms of health-care access or net health gains. We believe that equity considerations should be concerned with the presence, severity, and duration of illness as well as with longevity and lifetime benefits, i.e., the fair innings principle. Hence, health should be measured in terms of disability-adjusted life expectancy, health-adjusted life expectancy, or lifetime QALYs. These measures combine severity of illness and the fair innings principle, and may account for the prevailing concepts of equity [29]. We believe that the three approaches used in this article all incorporated (some of) these properties of equity.

Nevertheless, the approaches do not deal with equity in the same way; they all have their own strengths and weaknesses, and seem to be more complementary than mutually exclusive. Simply targeting underprivileged groups is the least comprehensive way to go about the equity–efficiency trade-off as it does not require any prior data collection on preferences of the general public or policymakers. In addition, a health gap is an intuitively understandable measure of differences in health between groups as well as the gap-reducing effect of interventions, either in absolute or relative terms. Nevertheless, targeting specific groups does not simultaneously assess the impact that an intervention has on equity and its cost-effectiveness. This means that the trade-off between equity and efficiency remains implicit, albeit it becomes less transparent.

Equity weighting explicitly combines those preferences with associated costs and health effects in an easily understandable measure: the equity adjusted CER, incorporating the willingness to give up life-years for equity reasons. This measure can be interpreted as a regular CER. Although it may be easy to interpret equity weights and equity-weighted outcomes, it may be difficult to understand in which way equity weights are measured and calculated.

Multicriteria decision analysis incorporates more aspects of health interventions than the other two approaches. Nevertheless, preferences about the relative importance of different criteria are measured in a different context and may be situation determined. Another disadvantage of this approach is the large amount of information that is lost as the performance on each criterion is categorized, weighted in a single outcome measure, i.e., the probability of selection. This limits the possibility to distinguish between different interventions. The number of potential profiles is especially limited if all investigated interventions are aimed at the same disease and same age group as in our example.

Our study shows that there are some applications of the equity–efficiency trade-off at the disposal of policymakers. These applications are potentially promising, because they may lead to better informed and more transparent reimbursement decisions. Better information can result in a shift from intuition-based policymaking to more evidence-based policymaking. Various high-income health-care systems are presently shifting toward a process of intervention assessment and appraisal. Typically, the National Institute for Health and Clinical Excellence in the UK has produced an article on social values. In general, governments can only accomplish more of health goals if the consequences of health policies for different goals are known [30].

Nevertheless, increased quantification of knowledge on the impact of health interventions will reduce the autonomy of policymakers to decide which reimbursement scheme is most attractive and a priority. This also may result in reluctance from policymakers toward such explicit applications of the equity–efficiency trade-off. Therefore, it seems most realistic to use the described incorporation of equitability approaches as a potential transparent support of policy with regard to accounting for the equity impact of health interventions.

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