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ORIGINAL ARTICLE

Asthma management practices in adults – findings from the German Health Update (GEDA) 2010 and the German National Health Interview and Examination Survey (DEGS1) 2008–2011

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Abstract

Objectives: In Germany, population-wide data on adherence to national asthma management guidelines are lacking, and performance measures (PM) for quality assurance in asthma care are systematically monitored for patients with German national asthma disease management program (DMP) enrollment only. We used national health survey data to assess variation in asthma care PM with respect to patient characteristics and care context, including DMP enrollment. **Methods:** Among adults 18–79 years with self-reported physician-diagnosed asthma in the past 12 months identified from a recent German National Health Interview Survey (GEDA 2010: $N = 1096$) and the German National Health Interview and Examination Survey 2008–2011 (DEGS1: $N = 333$), variation in asthma care PM was analyzed using logistic regression analysis. **Results:** Overall, 38.4% (95% confidence interval: 32.5–44.6%) of adults with asthma were on current inhaled corticosteroid therapy. Regarding non-drug asthma management, low coverage was observed for inhaler technique monitoring (35.2%; 31.2–39.3%) and for provision of an asthma management plan (27.3%; 24.2–30.7%), particularly among those with low education. Specific PM were more complete among persons with than without asthma DMP enrollment (adjusted odds ratios ranging up to 10.19; 5.23–19.86), even if asthma patients were regularly followed in a different care context. **Conclusions:** Guideline adherence appears to be suboptimal, particularly with respect to PM related to patient counseling. Barriers to the translation of recommendations into practice need to be identified and continuous monitoring of asthma care PM at the population level needs to be established.

Keywords

Adult population, asthma, disease management, Germany, national health survey, performance measures, quality indicators

History

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Introduction

Asthma is a common chronic disorder affecting approximately 5% of the adult population in Germany [1]. It can negatively impact the health-related quality of life, especially among those in whom asthma is poorly controlled [2]. Evidence-based recommendations regarding means to achieve and maintain optimal asthma control have been broadly disseminated through national and international asthma management guidelines [3,4]. In Germany, a National Disease Management Guideline (NDMG) for asthma was first published in 2005 as part of the National Disease Management Guideline program (German DM-CPG program) [5,6]. The program was set up in order to promote the continuity and transparency of care for patients with high-priority chronic health conditions across all health care

sectors [5]. The NDMG for asthma provides evidence-based, consensus recommendations on the diagnosis, therapy, and chronic care management [6].

At the national level, asthma hospital admissions and mortality both decreased in the past decade, while the prevalence of physician-diagnosed asthma has significantly increased during the same time period [1,7,8]. The level of well-controlled asthma, however, has been found to remain low in Germany compared to other European countries [9–11]. Low levels of guideline-conforming anti-inflammatory drug therapy, as observed in national and international studies, have been discussed to partly explain the extent of poor asthma control [10–13]. A potential lack of guideline adherence may also exist for non-medication aspects of asthma care as suggested by recent studies regarding guideline adherence in the primary care setting [14–19].

To identify gaps between current evidence and clinical practice, performance measures (PM) specific to asthma management have been developed [10,14,16,18–26]. In Germany, a preliminary set of guideline-derived PM has

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been proposed in the NDMG for asthma by December 2009 [3]. Documentation regulations of PM for quality assurance in asthma care have, so far, been restricted to the German national asthma disease management program (DMP) [27,28] which was introduced in 2006. National German asthma DMP participation is voluntary for both patients and physicians. Under provision of structural quality requirements, physicians are authorized to enroll patients into the asthma DMP program based on specific contracts with health insurance companies. By October 2014, 847 027 asthma patients had been enrolled by their attending primary care physicians [29]. Reimbursement is provided based on adequate documentation of selected patient characteristics and asthma specific measures [27]. According to data from a large German sickness fund, more than 50% of eligible general practitioners actively participated in an asthma DMP and provided full documentation of patient data as of 2014 [30].

Following the introduction of the asthma DMP, increased rates of guideline-conforming asthma care and improved asthma outcomes were observed in DMP patient cohorts of specific regions [31] and sickness funds [26]. Only one controlled study has so far compared process and outcome measures among asthma patients according to DMP enrollment based on a retrospective propensity score-matched cohort design. Higher guideline-conformity with recommendation on drug therapy was observed among asthma patients of a large German sickness fund who participated in DMPs than in those who did not; non-medication process measures were not examined in this previous study [32]. Importantly, PM for quality assurance in asthma care are systematically monitored for patients with German national asthma DMP enrollment only.

Against this background, we aimed to investigate medication and non-medication asthma care PM based on the information collected in two recent national health surveys for adults [33,34]. In particular, we examined variation in asthma care PM with respect to patient attributes and care context, including asthma DMP enrollment status and scheduled asthma care.

Methods

Study design and study population

The present analysis is based on adults aged 18–79 years with current self-reported physician-diagnosed asthma who participated in the “German Health Update” survey (GEDA) 2010 or in the National Health Interview and Examination Survey 2008–2011. GEDA 2010 was conducted as a national health telephone interview survey between September 2009 and July 2010. The GEDA 2010 target population comprised all adults (≥ 18 years of age) residing in private households reachable via landline telephone who could fluently speak and understand the German language. A two-stage sampling procedure was applied [34]. For sampling at the household level, a randomized last digit approach, the Gabler–Häder method based on publicly available directories of telephone numbers, was used [34,35]. For random sampling at the individual level, the “last-birthday-method” was applied [36]. In terms of data protection and informed consent, the study was approved by the Federal Commissioner for Data

Protection and Freedom of Information. Verbal-informed consent was provided by all participants prior to the interview. According to the standards of the American Association for Public Opinion Research (AAPOR) [37], the response rate was 28.3%, and the cooperation rate at the respondent level was 55.8%. Overall, 22 050 adults aged 18 years and older participated in GEDA 2010 [34].

The 2008–2011 wave of the German National Health Interview and Examination Survey for Adults in Germany (DEGS1) was conducted between November 2008 and November 2011. The target population of DEGS1 comprised adults aged 18–79 years with permanent residence in Germany. A random sample of first-time participants was drawn from local population registries using a two-stage cluster sampling design [33]. In addition, DEGS1 included a panel component, in which individuals who had previously participated in the 1997–1999 wave of the German National Health Interview and Examination Survey (BGS98) were re-contacted and invited to also participate in DEGS1. The DEGS1 study protocol was approved by the Federal and State Commissioners for Data Protection and the Charité – Universitätsmedizin Berlin ethics committee (No. EA2/047/08). Prior to the interview and examination, participants provided written-informed consent. The overall DEGS1 study population comprised 4193 first-time participants (response rate: 42%) and 3795 revisiting participants (response rate: 64%) [33]. Among these, 7091 men and women 18–79 years of age were personally seen at one of the 180 primary sampling units and had completed the medication interview.

Data collection and study variables

Data on health status, medical history, health-related behaviors and socio-demographic variables were collected by applying a computer-assisted telephone interview (CATI) technique in GEDA 2010 and using computer-assisted personal interviews (CAPI), self-administered questionnaires, as well as standardized measurements and tests in DEGS1. Participants were defined as having current asthma if they answered in the affirmative to two consecutive questions regarding whether they had ever been told by a physician that they had asthma and whether the condition had been present within the past 12 months.

While information on long-term drug treatment for asthma in the past 12 months was assessed among adults with asthma in both the surveys, data on non-drug asthma care PM and on asthma DMP enrollment were only collected in GEDA 2010. Information regarding the current use of inhaled corticosteroids was collected in only DEGS1 and was based on a standardized medication interview. As previously described in detail [38], the interview covered all medications (prescription or over-the-counter) used within the 7 days prior to the survey. Participants were asked to bring the original medication containers to the study center for scanning of the unique product code (in German: Pharmazentralnummer, PZN) and automated classification according to the WHO Anatomical Therapeutic Chemical (ATC) Classification System. Subgroup codes (inhaled corticosteroids and fixed combinations of inhaled corticosteroids with long-acting beta-(2)-adrenergic agonists) were combined and defined as

inhaled corticosteroid (ICS) therapy [3,10,14,18,23,24,26–28,39]. Information regarding PM of non-drug asthma care [3,10,14,16–28,39] was collected in only GEDA 2010. Participants with asthma were asked whether they had an asthma management plan and whether they had received the following services within the past 12 months: examination of inhalation technique if possessing a prescription inhaler, pulmonary function testing, smoking status assessment, advice on smoking cessation if currently smoking and at least one asthma-related scheduled check-up visit to a doctor. A categorical index on non-pharmacological actions adapted from Jonsson et al. [24] was calculated. Asthma DMP enrollment was defined based on an affirmative answer to the question whether participants with asthma participated in an asthma DMP in the past 12 months prior to the interview.

Independent variables were operationalized as follows. Age was categorized (18–54, 55–79 years). Anthropometric data were obtained from self-reported information in GEDA 2010 and from objective measurements in DEGS1. Body mass index (BMI) was calculated by dividing individual weight (kg) by height (m) squared and categorized as obese ($\text{BMI} \geq 30 \text{ kg/m}^2$) versus non-obese ($\text{BMI} < 30 \text{ kg/m}^2$) [40]. Current smokers were identified based on the information regarding current smoking (self-reported daily or occasional smoker) or non-current smoking (self-reported former or never smokers) [33,41]. Educational level was classified as low, middle, or high according to the three-level ISCED (International Standard Classification of Education) classifications [42]. Urban–rural residence was defined as metropolitan (community size $\geq 100\,000$ habitants) versus non-metropolitan (community size $< 100\,000$ habitants). Comorbidities including depression, diabetes mellitus and cardiovascular disease (chronic heart failure, myocardial infarction, stroke, or other coronary heart disease) were defined based on self-reported information obtained in standardized interviews as previously described in detail [41,43–45]. Expecting few cases of CVD among persons younger than 40 years of age, information on stroke, myocardial infarction or other coronary heart diseases in this age group was collected in the large national health interview survey (GEDA 2010, $N=22\,050$), whereas data collection was restricted to persons 40 years and older in the health interview and examination survey (DEGS1, $N=7987$). CVD prevalence estimates for DEGS1 were calculated coding all persons younger than 40 years of age as having no stroke, myocardial infarction, or other coronary heart diseases. Participants were defined as having a personal family physician if they answered in the affirmative to the question: “Do you have a personal family physician?”

Statistical analyses

Data analysis was performed using SPSS software with the complex sample module. To ensure representativeness at the population level, all results were weighted throughout the analyses and reported along with the unweighted number of participants who provided the information. Survey-specific weights for both surveys were composed of design weights adjusting for sampling probabilities and adjustment weights accounting for selective participation within strata of age, sex,

region, and educational attainment compared to German population statistics from 2008 for GEDA 2010 [34] and compared to German population statistics from 2010 for DEGS1 with an additional adjustment for community size [33]. Survey-specific weighting factors additionally accounted for reparticipation probabilities [33]. The Rao–Scott chi-square test of independence with second-order adjustment was used to globally test for differences in the distribution of proportions [46]. In addition to sex and age group (18–54, 55–79 years), BMI status (obese, non-obese), educational attainment level (low, middle, high), smoking status (current, non-current), presence of comorbidities (yes versus no), urban-rural residence and having a personal family physician were selected for adjustment as covariates in multivariable logistic regression models. Missing values were excluded from the analyses and complete case analyses were performed. A significance level of $p < 0.05$ was considered statistically significant based on two-tailed tests.

Results

In total, 21 481 adults aged 18–79 years were interviewed in the GEDA 2010 survey, and 7091 adults aged 18–79 years were interviewed, examined and provided information on current medication in the DEGS1 survey. Both survey samples and the subsets of 1096 GEDA 2010 participants (388 men and 708 women) and 333 participants from the DEGS1 survey (120 men and 213 women) with current self-reported physician-diagnosed asthma are described according to basic study characteristics in Table 1. In both surveys, approximately one half of GEDA 2010 survey participants with current asthma reported the use of long-term regular asthma medication in the past 12 months. Among GEDA 2010 survey participants with asthma, three-quarters had been seen for a scheduled asthma-related check-up visit within the preceding 12 months, and one-sixth had been enrolled in an asthma disease management (DMP) program.

Among all DEGS1 study participants with asthma, 38.4% currently used ICS therapy; this was true for 76.9% of participants with asthma on long-term asthma therapy (Table 1). With respect to non-medication asthma management in the past 12 months, approximately one-half of adults with current asthma reported pulmonary function monitoring and nearly two-thirds of adults with asthma were assessed for their smoking status in the past 12 months (Table 1). Among adults with asthma who were current smokers, two-thirds had been advised to quit smoking in the past 12 months. In contrast, only one-fourth received an asthma management plan, and approximately one-third of those holding a prescription inhaler reported an inhalation technique examination in the past 12 months (Table 1). Overall, merely one-fourth of GEDA 2010 study participants with asthma received at least three out of four selected non-drug asthma care services (Figure 1).

PM differed according to a variety of patient characteristics (Table 2). First, ICS use was more common among participants 55–79 years than among younger adults with asthma. Second, a self-management plan was less frequently provided to men than to women and to patients with low than intermediate or high educational attainment levels; and an

Table 1. Characteristics of the subpopulation with current asthma and the total study population, German Health Update (GEDA) 2010 and German National Health Interview and Examination Survey (DEGS1) 2008–2011.

Characteristics	GEDA 2010		DEGS1	
	Current asthma (N = 1096) % (95% CI)	Total (N = 21 481) % (95% CI)	Current asthma (N = 333) % (95% CI)	Total (N = 7091) % (95% CI)
Sex				
Women	60.3 (56.4–64.1)	50.8 (49.9–51.7)	64.6 (57.5–71.2)	50.3 (48.8–51.9)
Age				
55–79 years	43.2 (39.3–47.2)	35.9 (35.1–36.8)	36.0 (30.5–42.0)	35.3 (33.9–36.6)
Range	18–79	18–79	18–79	18–79
Educational attainment				
Primary	25.7 (21.6–30.2)	21.0 (20.1–22.0)	26.8 (20.7–33.9)	21.1 (19.6–22.7)
Middle	56.7 (52.7–60.6)	56.3 (55.4–57.1)	54.0 (46.7–61.2)	55.1 (53.3–57.0)
High	17.6 (15.6–19.8)	22.7 (22.2–23.3)	19.2 (14.6–24.9)	23.7 (22.2–25.3)
Current smoker				
Yes	31.1 (27.6–34.7)	31.0 (30.2–31.8)	31.0 (25.0–37.6)	29.9 (28.2–31.5)
BMI status ^b				
Obese	23.8 (20.4–27.5)	15.8 (15.2–16.5)	33.5 (27.4–40.2)	23.6 (22.1–25.2)
Comorbidities				
Diabetes	10.1 (7.7–13.2)	6.9 (6.4–7.4)	7.9 (5.0–12.2)	5.7 (5.1–6.4)
Cardiovascular diseases (CVD)	17.8 (14.7–21.4)	9.9 (9.3–10.5)	13.6 (9.7–18.7) ^a	8.4 (7.7–9.3) ^a
CVD among adults ≥40 years	23.9 (19.7–28.7)	14.2 (13.3–15.1)	21.4 (15.6–28.6)	12.5 (11.4–13.7)
Depression	13.8 (11.3–16.6)	7.2 (6.8–7.7)	9.0 (5.6–14.1)	5.8 (5.0–6.6)
Urban–rural residence				
Metropolitan	27.5 (24.0–31.3)	24.7 (24.0–25.5)	37.7 (28.1–48.3)	31.4 (24.6–39.0)
Personal family physician				
Yes	96.2 (94.7–97.2)	92.7 (92.3–93.1)	96.0 (92.9–97.8)	90.3 (89.0–91.5)
Long-term regular drug treatment for asthma				
Yes	50.7 (46.8–54.6)	–	43.1 (37.0–49.4)	–
Care context				
Enrollment in an asthma DMP	16.2 (13.6–19.3)	–	–	–
Structured review	77.6 (74.0–80.9)	–	–	–
Asthma care services				
Current use of inhaled corticosteroids	–	–	38.4 (32.5–44.6)	–
Current use of inhaled corticosteroids (individuals on long-term regular drug treatment for asthma only)	–	–	76.9 (67.3–84.4)	–
Lung function monitoring	54.1 (50.2–58.0)	–	–	–
Current self-management plan	27.3 (24.2–30.7)	–	–	–
Inhalation technique monitoring ^c	35.2 (31.2–39.3)	–	–	–
Smoking status monitoring	64.9 (61.1–68.6)	–	–	–
Smoking cessation advice ^d	66.6 (60.1–72.5)	–	–	–

For each variable, proportions and 95% confidence intervals (95% CI) are weighted and referred to survey participants with complete information for the respective variables.

^aStroke, myocardial infarction, or other coronary heart disease were only assessed among DEGS1 participants aged ≥40 years but proportion is extrapolated to population 18–79 years.

^bBMI status was calculated based on self-reported information in GEDA 2010 and from objective measurements in DEGS1.

^cIndividuals with current asthma and a prescription inhaler.

^dIndividuals with current asthma currently smoking.

Figure 1. Index of non-medication asthma care indicators among adults with current asthma in the GEDA 2010 survey. *Index on non-medication PMs of asthma care (provision of an asthma management plan and the following services within the past 12 months: monitoring of inhalation technique if possessing a prescription inhaler, pulmonary function and smoking status) among adults (18–79 years) with current asthma (GEDA 2010).

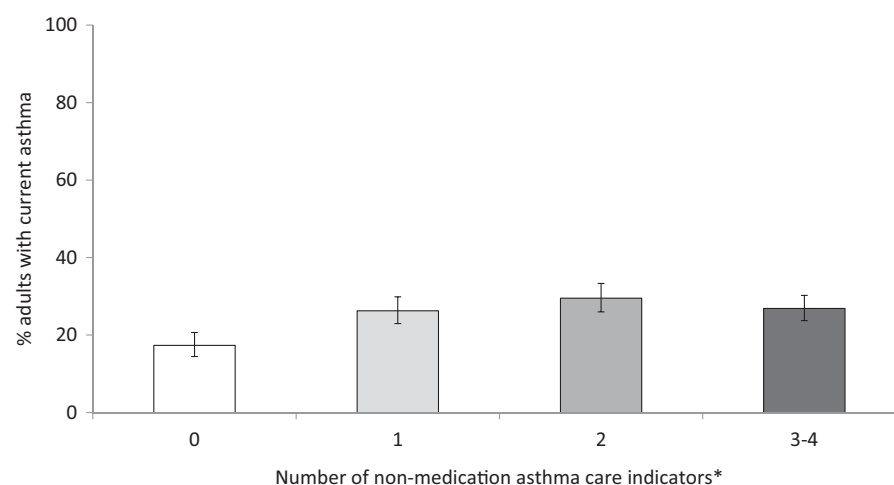


Table 2. Asthma care PM among adults with current asthma by study characteristics, German Health Update (GEDA) 2010 and German National Health Interview and Examination Survey (DEGS1) 2008–2011.

Characteristics	Lung function monitoring (past 12 months) % (n _{GEDA10})	Current self-management plan % (n _{GEDA10})	Inhaler technique check-up ^b (past 12 months) % (n _{GEDA10})	Smoking status monitoring (past 12 months) % (n _{GEDA10})	Smoking cessation Advice ^c (past 12 months) % (n _{GEDA10})	Structured review (past 12 months) % (n _{GEDA10})	Current use of inhaled corticosteroids% (n _{DEGS1})
Sex							
Men	50.3 (204)	20.6 (95)**	32.2 (98)	64.5 (243)	62.9 (61)	75.0 (296)	39.9 (53)
Women	56.6 (403)	31.8 (239)**	37.0 (214)	65.2 (450)	69.1 (139)	79.4 (563)	37.5 (98)
Age groups							
18–54 years	49.8 (348)*	26.6 (198)	31.0 (173)*	68.5 (456)*	60.7 (142)**	77.9 (528)	31.6 (67)**
55–79 years	59.8 (259)*	28.2 (136)	40.7 (139)*	60.2 (237)*	81.6 (58)**	77.2 (331)	50.3 (84)**
Educational attainment							
Primary	51.2 (64)	18.5 (26)*	35.6 (35)	67.9 (81)	81.4 (33)*	73.6 (89)	35.3 (25)
Middle	54.2 (329)	31.1 (202)*	36.7 (178)	65.8 (404)	63.1 (129)*	78.2 (473)	39.5 (88)
High	57.6 (213)	28.2 (106)*	30.6 (99)	58.4 (208)	52.8 (38)*	81.4 (296)	40.7 (38)
Current smoker							
No	56.5 (450)	28.3 (244)	34.9 (218)	57.4 (431)***	–	78.5 (614)	42.3 (120)
Yes	48.8 (157)	25.1 (90)	35.8 (94)	81.2 (262)***	66.6 (200)	75.6 (245)	30.3 (31)
BMI status							
Non-obese	57.7 (483)**	28.8 (264)	35.9 (248)	64.4 (530)	65.4 (153)	79.1 (667)	39.0 (105)
Obese	44.6 (114)**	23.2 (64)	34.4 (60)	67.8 (149)	73.2 (44)	75.1 (176)	36.3 (44)
Diabetes							
No	55.0 (555)	28.2 (308)	34.0 (279)	65.2 (641)	66.1 (188)	78.2 (788)	38.8 (139)
Yes	45.5 (49)	21.3 (26)	46.9 (31)	62.1 (49)	74.3 (12)	73.3 (68)	34.7 (10)
Cardiovascular diseases							
No	52.4 (499)	28.1 (282)	32.4 (250)*	63.5 (584)	61.8 (164)***	76.1 (723)	40.3 (126) ^a
Yes	62.5 (102)	23.4 (48)	47.3 (57)*	72.0 (102)	91.9 (32)***	85.7 (130)	32.0 (20) ^a
Depression							
No	52.7 (502)	26.1 (276)	34.7 (259)	62.3 (571)***	64.4 (153)	76.0 (723)**	37.1 (134)
Yes	63.3 (101)	35.6 (56)	38.7 (51)	80.4 (116)***	75.4 (46)	89.0 (131)**	51.4 (16)
Urban–rural residence							
Non-metropolitan	52.7 (371)	28.3 (217)	34.4 (203)	61.8 (419)**	57.4 (104)	78.7 (542)	39.9 (102)
Metropolitan	59.5 (172)	23.0 (82)	35.3 (77)	73.3 (198)**	70.8 (55)	78.4 (230)	35.7 (49)
Personal family physician							
No	49.3 (24)	21.4 (15)	25.1 (9)	56.8 (27)	63.5 (8)	62.1 (32)***	50.8 (6)
Yes	54.3 (583)	27.6 (319)	35.5 (303)	65.2 (666)	66.7 (192)	78.2 (827)***	38.1 (142)

For each variable, weighted proportions and unweighted *n* refer to survey participants who provided the information.

^aMyocardial infarction, stroke, or other coronary heart disease were only assessed among DEGS1 participants aged ≥40 years but proportion is extrapolated to population 18–79 years with current asthma. For all measures except inhalation technique monitoring and smoking cessation advice for current smokers, rates refer to the population with current asthma

^bThe process measure regarding inhalation technique monitoring refers to the population with current asthma and a prescription inhaler.

^cThe process measure regarding smoking cessation advice refers to the population with current asthma and a report of current smoking.

p Values are obtained from second order adjusted chi-square tests of independence: **p* < 0.05, ***p* < 0.01, ****p* < 0.001.

inverse relationship between smoking cessation advice to adults with asthma currently smoking and level of educational attainment was also observed. Third, except for smoking status assessment, provision of asthma care services was more complete for older than for younger adults with asthma and for those with than without chronic comorbid conditions. Finally, obese patients were less likely to receive lung function monitoring than non-obese patients.

DMP enrollment rates were significantly higher among women than men and among those with than without chronic

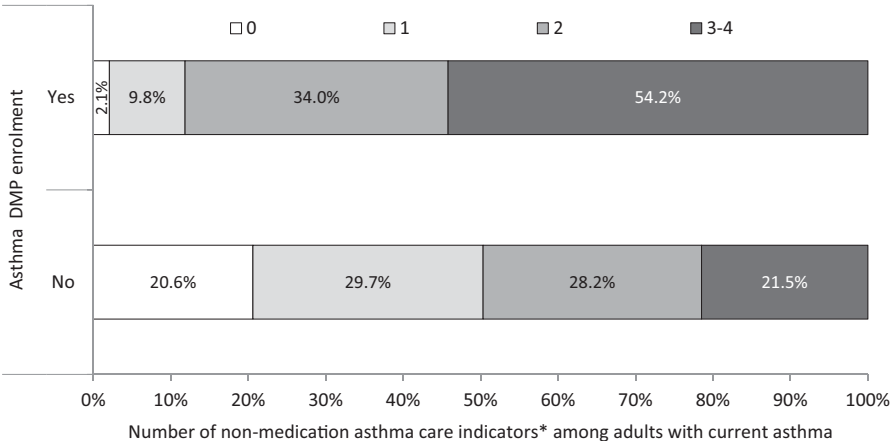
Table 3. Asthma DMP enrollment in the past 12 months among adults with asthma by study characteristics, German Health Update (GEDA) 2010. significance.

Characteristics	DMP enrollment % (n _{GEDA10})
Sex	
Men	11.9 (45)*
Women	19.1 (121)*
Age groups	
<55 years	13.8 (88)
55–79 years	19.4 (78)
Educational attainment	
Primary	16.1 (19)
Middle	17.0 (101)
High	13.2 (45)
Current smoker	
No	17.8 (124)
Yes	12.7 (42)
BMI status	
Non-obese	16.6 (131)
Obese	16.0 (32)
Diabetes	
No	16.0 (151)
Yes	19.4 (15)
Cardiovascular diseases	
No	14.6 (131)**
Yes	23.8 (34)**
Depression	
No	15.0 (135)*
Yes	24.5 (30)*
Urban–rural residence	
Non-metropolitan	15.3 (99)
Metropolitan	13.8 (41)
Personal family physician	
No	9.0 (4)
Yes	16.5 (162)

For each variable, weighted proportions and unweighted *n* refer to survey participants who provided the information.

p Values are obtained from the second-order adjusted χ^2 test of independence: **p* < 0.05, ***p* < 0.01.

Figure 2. Index of non-drug asthma care indicators with respect to DMP enrolment status among adults with current asthma in the GEDA 2010 survey. *Index on non-medication PMs of asthma care (provision of an asthma management plan and the following services within the past 12 months: monitoring of inhalation technique if possessing a prescription inhaler, pulmonary function and smoking status) with respect to asthma DMP enrolment in the past 12 months among adults (18–79 years) with current asthma (GEDA 2010).



comorbidities (Table 3). Among asthma patients with DMP enrollment, 97.7% received a structured review in the past 12 months compared to only 73.4% of patients without DMP enrollment. Among adults with asthma enrolled in an asthma DMP program, a significantly higher proportion received at least three out of four non-drug care services than people with asthma but without DMP enrollment (Figure 2). As shown in Table 4, the strength of the association with DMP enrollment varied considerably by specific PM. In particular, annual monitoring of pulmonary function, the provision of a self-management plan and an annual inhalation technique monitoring among those with prescription inhalers were moderate to strongly related to DMP enrollment in bivariate and multivariate analyses (Figure 3; Table 4). When considering all participants with a scheduled asthma-related check-up visit in the past 12 months, a similar pattern of associations with non-medication PMs was observed (Supplementary Table 1).

Discussion

The present study provides population-based information regarding asthma management practices in Germany at the national level. Our results suggest that ICS coverage was 76.9% among adults reporting long-term anti-asthmatic drug therapy and 38.4% among all adults with asthma. Regarding non-drug asthma management, only about one-fourth of adults with asthma reported to receive at least three out of four selected care services. Among these indicators, provision of a doctor-written asthma management plan and inhalation technique monitoring were least likely provided to asthma patients. Coverage for asthma care services also varied by patient characteristics. In particular, holding a self-management plan was related to low educational attainment. Moreover, guideline conformity in asthma care appears to be less optimal in asthma patients not enrolled in an asthma DMP, even if they were regularly followed in a different care context.

Our findings indicate the following. First, guideline conformity might be suboptimal with respect to the provision of a doctor-written asthma management plan and a regular assessment of inhaler technique, as suggested by previous population-based studies [10,21,22] and primary care-based research [14–18,24,47]. The use of written action plans is a principal component of self-management which can contribute to better asthma control [3,4,48]; however, most of the participants with asthma in our study did not report current

Table 4. Association of asthma DMP enrollment in the past 12 months (yes versus no) with non-medication asthma care PM among adults with current asthma German Telephone Health Interview Survey (GEDA) 2010.

		Odds ratios for having received an intervention (yes versus no)					
		% (n/N)	OR (95% CI) ⁰	OR (95% CI) ¹	OR (95% CI) ²	OR (95% CI) ³	OR (95% CI) ⁴
PM 1: Pulmonary function monitoring in the past 12 months							
No DMP enrollment		46.6 (446/910)	(N = 1076) Reference	(N = 1076) Reference	(N = 1051) Reference	(N = 1031) Reference	(N = 930) Reference
DMP enrollment		90.0 (149/166)	10.37 (5.52–19.48)	10.01 (5.33–18.82)	9.99 (5.31–18.78)	9.84 (5.22–18.54)	10.19 (5.23–19.86)
PM 2: Current asthma management plan							
No DMP enrollment		22.6 (233/912)	(N = 1077) Reference	(N = 1077) Reference	(N = 1052) Reference	(N = 1032) Reference	(N = 930) Reference
DMP enrollment		52.3 (96/165)	3.76 (2.44–5.80)	3.60 (2.31–5.61)	3.61 (2.32–5.62)	3.51 (2.25–5.50)	3.43 (2.15–5.46)
PM 3: Inhalation technique monitoring in the past 12 months ^a							
No DMP enrollment		30.7 (223/732)	(N = 886) Reference	(N = 886) Reference	(N = 866) Reference	(N = 847) Reference	(N = 763) Reference
DMP enrollment		54.3 (82/154)	2.68 (1.70–4.22)	2.56 (1.61–4.06)	2.61 (1.63–4.15)	2.46 (1.53–3.94)	2.13 (1.29–3.52)
PM 4: Smoking status monitoring in the past 12 months							
No DMP enrollment		63.4 (561/904)	(N = 1,067) Reference	(N = 1,067) Reference	(N = 1,042) Reference	(N = 1,022) Reference	(N = 922) Reference
DMP enrollment		71.2 (120/163)	1.43 (0.89–2.29)	1.50 (0.92–2.43)	1.65 (1.00–2.73)	1.53 (0.92–2.57)	2.16 (1.26–3.69)
PM 5: Smoking cessation advice in the past 12 months ^b							
No DMP enrollment		63.9 (163/274)	(N = 316) Reference	(N = 316) Reference	(N = 307) Reference	(N = 300) Reference	(N = 257) Reference
DMP enrollment		80.9 (33/42)	2.39 (0.98–5.79)	2.43 (0.97–6.09)	3.27 (1.33–8.07)	2.65 (1.03–6.86)	1.89 (0.71–5.03)

For each variable, weighted proportions and unweighted *n* refer to survey participants who provided the information. Unweighted *n* may vary due to missing values.

Odds ratio (OR) and 95% confidence interval (95% CI) obtained from multivariable logistic regression analyses; crude OR⁰; OR¹ adjusted for age groups and sex; OR² adjusted for age groups and sex plus body mass index status, educational attainment status and smoking status. OR³ additionally adjusted for comorbidities, OR⁴ additionally adjusted for urban–rural residence and having a personal family physician. For all measure but inhalation technique monitoring and smoking cessation advice for current smokers, rates refer to population with current asthma.

^aProcess measure on inhalation technique monitoring refers to population with current asthma and prescription inhaler.

^bProcess measure on smoking cessation advice refers to population with current asthma and self-reported current smoking.

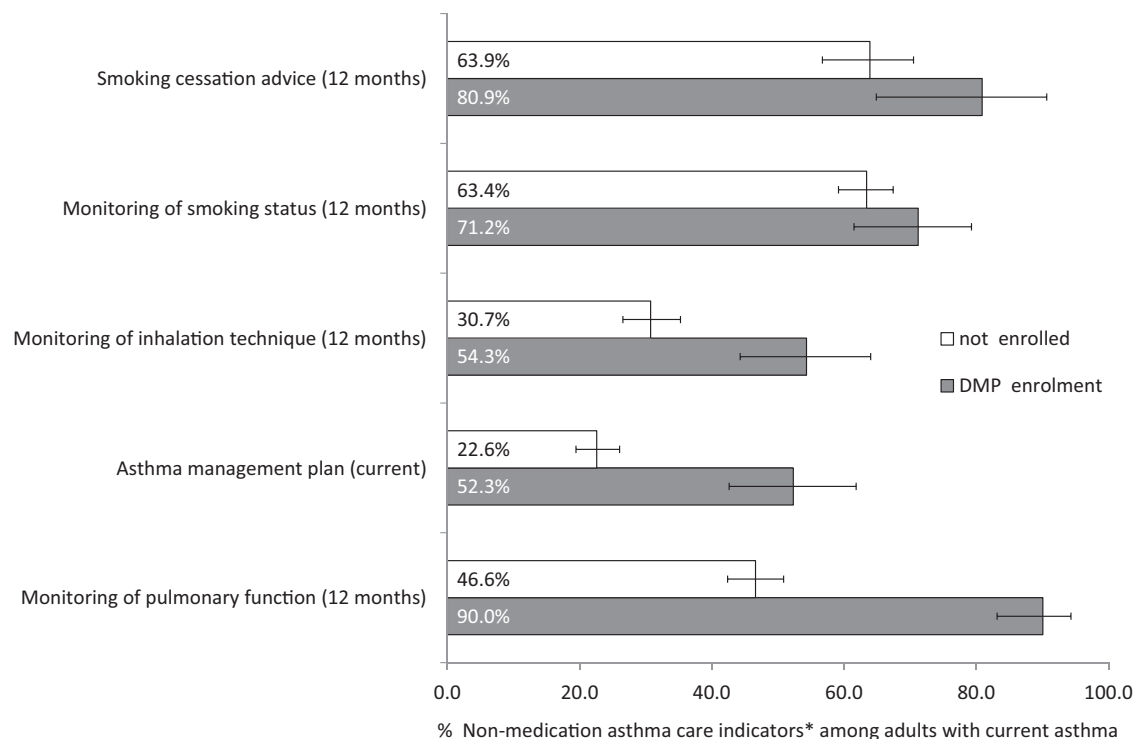


Figure 3. Variations in non-medication asthma care indicators with respect to DMP enrolment status among adults with current asthma in the GEDA 2010 survey. Non-medication PMs of asthma care including provision of an asthma management plan and the following services within the past 12 months: monitoring of inhalation technique if possessing a prescription inhaler, pulmonary function and smoking status, and advice on smoking

holding of an asthma management plan. Compared to findings of the Asthma Insight and Reality (AIRE) survey in 1999, the prevalence of this indicator was only slightly lower among German adults with asthma than observed in the present study (21.9% in AIRE versus 27.3% in GEDA 2010). Overall, the proportion of asthma patients provided with a doctor-written management plan among the AIRE survey participants from seven European countries ranged between 9.5 and 49.2% [10]. In a recent analysis of national health survey data from Australia, an even lower proportion of only 14.4% of population 15 years and older with current asthma had an asthma management plan [21]. In the US, where this indicator has been a Healthy People 2020 objective (RD-7.1), 34.2% of children and adults with asthma currently hold an asthma management plan, according to results of the national health interview survey (NHIS) [20,22].

The low proportion of asthma patients provided with an asthma management plan observed here and elsewhere is in line with results of a recent knowledge survey of family doctors and trainees in Lower Saxony and Bavaria [10,15–17,21,22,47]. This study revealed high variation in physicians' adherence to guideline recommendations. In particular, 42% of family doctors did not opt for the provision of an asthma management plan [17]. Possible barriers that have been discussed not only involve the extent of perceived relevance and practicability or the degree of certainty and confidence in issuing an action plan, but might also relate to a mismatch between physicians' and patients' perceptions of asthma and approaches to asthma management [15–17,48,49].

At 35%, the proportion of asthma patients with a prescription inhaler who had received an inhalation technique examination in the past 12 months was also low in the present

study. Although proper inhaler technique is required for adequate drug delivery to the airways, inhaler mishandling is common among adults with asthma [3,50–52]. Patients' ability to use their inhaler device relates to their level of asthma control [51–53], and monitoring of proper inhaler technique at least once annually is highly recommended as an integral part of asthma management [3,11,50,52,54]. Nonetheless, studies on inhaler education practice in primary and specialist care settings have found significant rates of asthma patients not receiving practical demonstrations or regular check-ups of proper inhalation technique [24,50,55,56]. The low proportion of asthma patients provided with an inhalation technique examination found in our study also agrees with results of a German study on guideline adherence in chronic obstructive pulmonary disease management. One-third of primary care physicians reported that they do not perform regular inhalation technique monitoring [57]. In Germany, physicians have limited control over choosing an appropriate inhaler device for their patients. Product choice and continuity may be compromised by the fact that pharmacists can substitute devices based on changing discount contracts between sickness funds and pharmaceutical companies [58]. It is conceivable that this situation might in part influence the implementation of inhaler technique education. Further research is needed to gain better insight into respective barriers and facilitators in clinical practice.

Second, lung function monitoring within the past 12 months was reported by one-half of GEDA 2010 survey participants with asthma in the present study. This estimate is somewhat lower than that observed among German participants of the 1999 AIRE survey [10]. Overall in 1999, coverage for this indicator ranged from 24.0% in Italy to

68.4% in Germany [10]. A more recent primary care-based investigation into guideline adherence in Sweden revealed that despite the availability of spirometry within a structured care program for patients with asthma, more than 40% of adult asthma patients did not obtain a pulmonary function test at their initial visit, and approximately one-third did not receive objective measurement at their regular follow-up evaluation [14]. Our finding that about 50% of asthma patients received objective monitoring of their lung function in the past 12 months may suggest that although diagnoses and management guidelines recommend spirometry as a basic requirement for reliable diagnosis and comprehensive monitoring of asthma, its underutilization is common in general practice [3,4,6,19,23,28].

Third, measures of smoking prevention such as screening of adults with asthma for tobacco use and cessation advice for those currently smoking were most frequently provided to study participants with asthma. These results are in line with a recent study on asthma guideline adherence in Germany indicating good acceptance of measures for smoking cessation among family doctors; this is in contrast to considerable reservations regarding providing written personalized management plans [17]. Moreover, our findings gain support from a study by Boulet et al., who observed that provision of a written action plan for exacerbation management and inhalation technique assessment at every visit had been less frequently implemented in primary care settings than other key recommendations (such as smoking cessation counseling) included in a global assessment tool of asthma guideline implementation in Canada [18]. However, as identification of smokers and advice regarding cessation constitute principal components of smoking cessation interventions, both actions are considered essential contributions to effective asthma management and should be provided at every opportunity [3,19,25,59]. Many physician-related barriers including interference with the doctor–patient relationship or low expectations of success have been discussed [60,61]. Structural barriers such as time constraints may add or even interfere with these [61,61]. For example, in Germany evidence-based smoking cessation interventions including structured, integrated programs are not covered by health insurance [62]. This might add to low expectations of success among physicians. In line with this, in a German study on guideline adherence in chronic obstructive pulmonary disease management, it was found that most of the participating primary care physicians and pulmonologists expressed difficulties in implementing measures regarding smoking cessation [57].

Fourth, ICS are recommended as a first-line treatment for long-term anti-inflammatory therapy of persistent asthma [3]. In the present study, ICS were currently used by 38% of all adults with asthma, whereas the proportion was twice as high for patients on long-term drug therapy for asthma. In European population-based surveys conducted in the 1990s, the overall proportion of German asthma patients receiving ICS was 31% in 1994–1996 [63] and ranged between one-third among those with mild to severe persistent symptoms (30–36%) and 18% among those with intermittent symptoms in the 1999 AIRE study [10]. Similar results were obtained from the 1997–1999 wave of the German National Health Interview and Examination Survey for Adults (BGS98) [12].

In this previous survey, 34.8% of adult participants with asthma in the past 4 weeks were currently using ICS [12]. In analyses of the Bavarian statutory health insurance physician association's database, 179 439 of 483 051 consistent asthma patients (37%) had received ICS prescriptions (74 420 with ICS and 105 019 with a fixed combination of ICS/long-acting beta-(2)-adrenergic agonists) in 2005–2006 [13]. Compared to these previous results, our findings indicate that overall ICS use among asthma patients did not increase in Germany but remained low in comparison to other European countries [14,63]. However, we observed that 76.9% of patients on long-term anti-asthmatic therapy received ICS. Compared to those asthma DMP target rates proposed for non-medication PM that were assessed in our study [26], better guideline adherence for medication than non-medication aspects of asthma care can be assumed [15,24]. Nevertheless, the actual need for long-term treatment might have been much higher in the general population considering that asthma is not well-controlled in about one-half of current asthma patients in Germany [9,11].

Finally, in this population-based nationwide study, we observed that asthma care PM were more complete for patients with than without DMP enrollment. The strength of this association differed between specific PM and was much more pronounced for pulmonary function monitoring than for non-medication asthma care services involving patient education and doctor–patient interaction or for preventive services regarding smoking assessment and cessation advice not exclusive to the management of asthma. Considering only adults with asthma enrolled in an asthma DMP, our results are comparable to the most recent results of an asthma DMP evaluation in a nationwide patient cohort of a large sickness fund regarding the provision of asthma management plans (52 versus 54%) and inhalation technique examinations (54 versus 77%) [26,64]. Structured asthma care in Germany, as indicated by scheduled follow-up visits, can take place outside of DMPs. We therefore additionally analyzed the association between asthma PM and DMP enrollment in the subset of study participants with asthma reporting at least one scheduled asthma-related check-up visit in the past 12 months. Associations still indicated that non-drug asthma care was more complete with than without DMP enrollment albeit the strength of the associations was somewhat weaker than the results from the total sample of adults with asthma.

In the present investigation, data from two large nationally representative health surveys of adults in Germany were used. We assessed current ICS coverage on the basis of unique data on the actual use of medications among adults with asthma and analyzed variation of drug and non-drug asthma care PM with respect to patient attributes. Although a questionnaire-based definition of physician-diagnosed asthma is established in epidemiological studies, we cannot exclude misclassification [65]. In particular, among older persons, asthma is known to be under-diagnosed or confounded by chronic obstructive pulmonary disease (COPD) [66]. This is of particular relevance to ICS coverage rates which might have been underestimated especially among persons of older age. Notably, in our study, utilization of ICS appears to be particularly low among younger asthma patients as previously reported [12].

In our study, we reported differences in non-drug asthma management with respect to structured care. Since there is no mandatory documentation outside of DMPs and hence, non-drug treatment cannot be studied on the basis of available routine data, our findings add to the limited knowledge on the provision of non-medication health care services to asthma patients in the general population under different care conditions. Still, information on non-medication asthma PM was self-reported. Given that documentation in the routine care setting is not regulated and hence incomplete outside of DMPs, patient reported information obtained on the basis of national health surveys offer a valuable data source and have been used for national asthma monitoring in other countries [21,22].

As in a previous population-based survey on diabetes management practices in relation to DMP participation in Germany, information on DMP enrollment was based on self-report, and this may have introduced misclassification due to over- or underreporting [67]. However, our estimated DMP asthma participation rate of 16.2% is supported by an estimate ranging from 15.1 to 16.4% for the GEDA 2010 study period, as calculated from DMP statistics ($n = 622\,525$ asthma DMP participants by September 2009 and $n = 673\,566$ by July 2010 [29]) and estimated prevalence of asthma in the past 12 months from national health surveys standardized to the German population amounting to 5.3% or about 3 584 939 adults (GEDA 2010) [34] and 4.1% or about 529 842 children and adolescents in Germany [68].

The present investigation is based on an observational cross-sectional study design. Therefore, we cannot reach any conclusions regarding direction or causality with respect to the observed associations. This is of particular relevance to our findings indicating variation in clinical asthma management according to patient attributes and care context. Differences in the provision of asthma management plans or smoking prevention services with respect to educational attainment as observed here and elsewhere could reflect physician-related behavioral barriers toward different patient groups and/or patient-related barriers in care seeking [49,69]. However, our findings suggest differences in clinical asthma management with regard to several patient characteristics, and thus, add to the limited evidence from population-based investigations on variations in asthma care according to patient attributes [69].

Finally, low response rates are subject to potential selection bias. In DEGS1, the participation rate among newly recruited participants (42%) was even lower than the response rate obtained in the German National Health Interview and Examination Survey 1997–1999 (62%) [33]. This corresponds to an overall decline in participation rates observed in European national health examination surveys of adults during the past decades with current reports of comparable rates as low as 40% [70,71]. Declining participation rates have also been reported for telephone interview surveys [72,73], and the rate obtained in GEDA 2010 (28.3%, cooperation rate at the respondent level: 55.8% [37]) is consistent with rates reported from other surveys at the national level in Germany [74,75]. In order to assure representativeness at the population level, results were carefully weighted to adjust for sampling design and non-response throughout the analysis [34].

Conclusions/key findings

Compared to findings of earlier population-based studies, the results of the present analysis suggest that little or no change has taken place in recent years with respect to overall ICS coverage or use of management plans in adult asthma care. Further research is needed to gain better insight into the structural, organizational, physician-, patient-, and process-related barriers and facilitators specific to the implementation of key recommendations in clinical practice. This is of particular relevance given that we observed considerable variation in clinical asthma management with regard to patient characteristics including educational attainment. In particular, higher guideline-conforming asthma care was indicated for asthma patients with than without DMP enrollment. Shortcomings may, thus, affect a majority of asthma patients who are not enrolled in the national asthma DMP, even if they were regularly followed in a different care context. At the national level, continuous monitoring of asthma care process and outcome measures needs to be established to ensure effectiveness and equity of health care provided to asthma patients.

Declaration of interest

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Supplementary material available online

Supplementary Table 1

Supplementary Table 1. Association of asthma DMP enrolment in the past 12 months (yes vs. no) with non-medication asthma care PM among adults with current asthma and structured review for asthma in the past 12 months. GEDA 2010.

Odds ratios for having received an intervention (yes vs. no)						
	% (n/N)	OR ⁰ (95%CI)	OR (95%CI) ¹	OR (95%CI) ²	OR (95%CI) ³	OR (95%CI) ⁴
PM 1: Pulmonary function monitoring in the past 12 months						
		(N=1,064)	(N=1,064)	(N=1,039)	(N=1,019)	(N=919)
No DMP enrolment	57.8 (409/681)	Reference	Reference	Reference	Reference	Reference
DMP enrolment	90.1 (144/160)	6.67 (3.45-12.89)	6.32 (3.28-12.20)	6.49 (3.36-12.51)	6.67 (3.46-12.84)	7.43 (3.70-14.92)
PM 2: Current asthma management plan						
		(N=1,065)	(N=1,065)	(N=1,040)	(N=1,020)	(N=919)
No DMP enrolment	26.4 (201/683)	Reference	Reference	Reference	Reference	Reference
DMP enrolment	53.4 (94/159)	3.20 (2.04-5.03)	3.05 (1.92-4.84)	3.19 (2.02-5.05)	3.16 (1.99-5.02)	3.12 (1.93-5.04)
PM 3: Inhalation technique monitoring in the past 12 months *						
		(N=875)	(N=875)	(N=855)	(N=836)	(N=753)
No DMP enrolment	34.8 (196/585)	Reference	Reference	Reference	Reference	Reference
DMP enrolment	55.2 (79/148)	2.32 (1.45-3.70)	2.20 (1.36-3.57)	2.28 (1.40-3.71)	2.19 (1.34-3.59)	1.90 (1.13-3.18)
PM 4: Smoking status monitoring in the past 12 months						
		(N=1,055)	(N=1,055)	(N=1,030)	(N=1,010)	(N=911)
No DMP enrolment	69.2 (454/678)	Reference	Reference	Reference	Reference	Reference
DMP enrolment	72.1 (116/157)	1.15 (0.70-1.89)	1.16 (0.70-1.90)	1.26 (0.74-2.13)	1.20 (0.71-2.05)	1.84 (1.05-3.22)
PM 5: Smoking cessation advise in the past 12 months **						
		(N=314)	(N=314)	(N=305)	(N=298)	(N=255)
No DMP enrolment	69.9 (129/199)	Reference	Reference	Reference	Reference	Reference
DMP enrolment	80.7 (32/41)	1.81 (0.73-4.48)	1.83 (0.72-4.62)	2.41 (0.96-6.03)	2.05 (0.80-5.26)	1.49 (0.56-4.01)

For each variable, weighted proportions and unweighted n refer to survey participants who provided the information. Unweighted n may vary due to missing values.

Odds ratio (OR) and 95% confidence interval (95%CI) obtained from multivariable logistic regression analyses; crude OR⁰; ¹ OR adjusted for age groups and gender; ² OR adjusted for age groups and gender plus body mass index status, educational attainment status, and smoking status. ³ OR additionally adjusted for comorbidities, ⁴ OR additionally adjusted for urban-rural residence and having a personal family physician.

For all measure but inhalation technique monitoring and smoking cessation advice for current smokers, rates refer to population with current asthma; * process measure on inhalation technique monitoring refers to population with current asthma and prescription inhaler; and ** process measure on smoking cessation advice refers to population with current asthma and self-reported current smoking.