病日	PCI後1日目	2日目	3日目	4日目	5日目	6日目	7日目	8日目	9日目	10日目	11日目	12日目	13日目	14日目
達成目標	・急性心筋梗塞およびカテーテル検査に伴う合併症を防ぐ	・急性心筋梗塞およびカテーテル検査に伴う合併症を防ぐ	・急性心筋梗塞に伴う合併症を防ぐ	・心筋虚血が起きない	・心筋虚血が起きない ・服薬自己管理ができる ・退院後の日常生活の注意点について知ることができる			・心筋虚血が起きない ・退院後の日常生活の注意点について理解ができる			・亜最大負荷で虚血がない ・退院後の日常生活の注意点について言える			退院
負荷検査・リハ	・圧迫帯除去，創部消毒 ・室内排便負荷	・尿カテーテル抜去	・末梢ライン抜去 ・トイレ排泄負荷	・200m 歩行負荷試験 ・合格後 200 m 歩行練習 1日3回 ・栄養指導依頼	・心臓リハ依頼 ・心臓リハ開始日の確認	・心臓リハ室でエントリーテスト ・心リハ非エントリー例では500m 歩行負荷試験		・心臓リハ室で運動療法 (心臓リハ非エントリー例では，マスターシングル試験または入浴負荷試験)						
安静度	・圧迫帯除去後床上自由	・室内自由	・負荷後トイレまで歩行可	・200m 病棟内自由		・亜最大負荷試験合格後は入浴可および院内自由								
食事	・循環器疾患普通食（1,600kcal，塩分 6 g） ・飲水量指示			・循環器疾患普通食（1,600kcal，塩分 6 g） ・飲水制限なし										
排泄	・尿留置カテーテル ・排便：ポータブル便器	・尿留置カテーテル ・排便：ポータブル便器	・排尿・排便：トイレ使用											
清潔	・洗面ベッド上 ・全身清拭，背・足介助	・洗面：洗面台使用 ・全身清拭，背・足介助		・洗面：洗面台使用 ・清拭：背部のみ介助		・洗面：洗面台使用 ・患者の希望に合わせて清拭		・洗面：洗面台使用 ・患者の希望に合わせて入浴						

【図 2】急性心筋梗塞 14 日間クリニカルパス（国立循環器病研究センター）（文献 1 より引用）

疾患，動脈硬化と危険因子，食事療法，運動療法，薬物療法，日常生活の工夫，ストレス管理，復職などについての講義に参加してもらう．リハが進み安静度が徐々にアップされても，積極的な運動ができない患者もいる．運動負荷試験を行い，運動量を設定することが望まれる．本症例では元々の ADL が杖歩行レベルであり，心肺運動負荷試験は行っていない．日常生活で必要な T 字杖での平地歩行，手すりを用いての数段の階段昇降を行い，現時点でできる安全な移動を習得してもらった．

30 病日で老人ホームへ退院したが，その時点では 1 km 程度の連続歩行が可能であった（歩行後血圧 120/54 mmHg，脈拍 95 bpm）．また，手すりがあれば 20 cm 階段は 1 足 1 段で昇降可能となり，昇降後の血圧は 126/52 mmHg，脈拍は 82 bpm であった．最終評価では歩行速度は 97.1 m/分に達した．なお，一般に横断歩道を渡るために必要な速さは 60 m/分と言われている．

内科医ならこうしてみよう

日本では段階的な制限の解除により，退院に向けた急性期リハが徐々に進められていく．経皮経管的冠動脈形成術を行った症例では，一般に入院期間は 2 週間程度である．血行再建をしても動けないままでは退院も困難である．動けない症例では，起立性低血圧の有無を確認したい．また，特に高齢者では入院前の日常生活の様子や，整形外科的な疾患の有無を確認することも必要となる．起立性低血圧のために起き上がれない患者では，利尿薬など降圧薬の見直し

や，下半身への過剰な血液供給を防止する策，下肢筋肉の血液循環ポンプ作用を高める工夫が有効である．心筋梗塞の治療をしても，すぐに入院前以上の活動能力が得られるわけではなく，必要であれば社会資源の活用，骨関節疾患の合併があれば整形外科受診を行う．回復期リハの有用性も確立されており，緊急心臓カテーテル検査で呼び出される回数を減らすためにも，回復期リハを患者に勧めていただきたい．

診療報酬の観点から

心筋梗塞後のリハは医療保険上，「心大血管リハビリテーション料」として算定できる．そのためには施設基準を満たして届け出る必要があり，施設基準により診療報酬は異なる．残念ながら心臓リハの中核となる教育には診療報酬は認められていない．

心大血管リハビリテーション料の対象患者には急性心筋梗塞患者などが含まれ，リハ開始から150日以内に算定できる．20分で1単位として計算され，施設基準Ⅰをとっていれば1単位200点，施設基準Ⅱであれば1単位100点が算定される．入院中で，治療開始から30日以内は1単位あたり30点を加算する．標準的な実施時間は，1回1時間(3単位)程度とされる．

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ORIGINAL REPORT

HOW DID REHABILITATION PROFESSIONALS ACT WHEN FACED WITH THE GREAT EAST JAPAN EARTHQUAKE AND DISASTER? DESCRIPTIVE EPIDEMIOLOGY OF DISABILITY AND AN INTERIM REPORT OF THE RELIEF ACTIVITIES OF THE TEN REHABILITATION-RELATED ORGANIZATIONS

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Objective: **Inter-organizational coordination is important for rehabilitation disaster relief. The 2011 Great East Japan Earthquake and Disaster was unprecedented, being geographically widespread and multifaceted. Faced with the crisis, rehabilitation professionals established the 10 Rehabilitation-Related Organizations of Rehabilitation Support Service (10-RRO). The objectives of this paper are to provide descriptive epidemiology and assess the activities of 10-RRO.**

Design: **Descriptive.**

Methods: **Epidemiological data on disability were collected, mainly from official sources. Relief activities were reviewed from daily reports, and the preparedness, initial response and functioning of 10-RRO were assessed with a questionnaire directed at 36 executives of individual organizations.**

Results: **The disaster was characterized by a very low ratio of injuries to death of 0.372, and an odds ratio of deaths among disabled persons of 2.32. 10-RRO provided relief activities at 3 shelters. The total number of dispatch days ranged from 107 to 146, and the cumulative number of professionals and evacuees served was 1,202 and 7,300, respectively. Support activities included prevention of immobilization, daily life support, environmental improvement and transition to temporary housing. The questionnaire survey revealed poor preparedness, satisfactory initial response and support activities, and problems of data collection and advocacy.**

Conclusion: **The disaster was characterized by minimal trauma and a great need for preventing immobilization. This first collaborative endeavour was successful.**

Key words: natural disaster; preparedness; immobilization syndrome; community-based rehabilitation.

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INTRODUCTION

Following a series of large-scale natural disasters, such as Hurricane Katrina (1–3), the Kashmir earthquake (3, 4), the Sichuan earthquake (3) and the Haiti earthquake (3), there has been increasing international interest in rehabilitation support at the time of disasters (3, 5). During disaster relief activities, coordination among organizations and professionals is important (6–8). However, as symbolized by the panel discussion focusing on the critical question "How can rehabilitation actors coordinate better in disaster?" at the 6th International Society of Physical and Rehabilitation Medicine (ISPRM) (9), well-coordinated relief activities by various rehabilitation professionals are not easy.

Faced with the recent Great East Japan Earthquake and Disaster (GEJED), which occurred on 11 March 2011, individual rehabilitation-related organizations responded quickly within a few days of the disaster, but they acted independently without inter-organizational coordination. This often resulted in duplication of services or a lack of necessary services, and placed an unnecessary burden on local government officials and healthcare professionals, of coordinating surging volunteers, when the local officials and professionals were often disaster victims themselves and became exhausted in trying to fulfil their responsibilities.

Compared with the Great Hanshin-Awaji Earthquake in 1995 (10, 11), the GEJED was unprecedented, being geographically

widespread and multifaceted (earthquake, tsunami and nuclear power plant failure) (12, 13). This made it impossible simply to apply previous experience, and forced rehabilitation professionals to act together, in particular to prevent immobilization syndrome and progressive functional deterioration among frail elderly survivors and persons with pre-existing disabilities who were forced to stay in shelters that were not designed to encourage physical activity. This prompted us to establish the "10 Rehabilitation-Related Organizations of the Great East Japan Earthquake Rehabilitation Support Service" (10-RRO) 1 month after the disaster in order to try to cope with this unprecedented national crisis.

The objectives of this report are to provide descriptive epidemiology with an emphasis on disability, to describe how 10-RRO was formed and managed, to review its relief activities, and to perform self-evaluation of the activities using a questionnaire directed at the executives of each organization.

METHODS

Descriptive epidemiology of Great East Japan Earthquake and Disaster

Information about the epidemiological data, with emphasis on disability, was searched by accessing the websites of official agencies, such as the Emergency Disaster Countermeasures Headquarters of the National Police Agency, the Ministry of Health and Welfare and the local governments of affected areas. If the information was unavailable through these agencies, other sources, such as newspaper websites, non-governmental organizations (NGOs) and researchers, were accessed. Based on the data gathered, the descriptive epidemiology of the GEJED was summarized, and the injury to death ratio and odds ratio (OR) of death for persons with disability were calculated.

Formation and management of 10 Rehabilitation-Related Organizations

On 13 March 2011, the Earthquake Disaster Relief Headquarters of the Japanese Association of Rehabilitation Medicine contacted 5 rehabilitation-related organizations (the Japan Association of Rehabilitation Hospital and Institution, the Kaifukuki (sub-acute) Rehabilitation Ward Association, the Japanese Physical Therapy Association, the Japanese Association of Occupational Therapists, and the Japanese Association of Speech-Language-Hearing Therapists) and called for coordination of the disaster management. Some collaborative activities, such as exchange of information and development of a system to accept patients from the affected areas, were commenced. However, amidst great confusion, individual organizations had made great efforts to collect information, confirm the safety of their members and formulate relief activity strategies, and were occupied with their own organizational matters with insufficient time and energy to pursue active inter-organizational collaboration. The lack of experience of such collaboration in past disasters complicated the situation. Therefore, it was 1 month after the disaster that we began collaborative relief activities, and finally established 10-RRO, consisting of the 6 organizations mentioned above and the Adult Day-care Liaison Council Japan, the Home Rehabilitation Association, the Community-based Rehabilitation Support Council, and the Japan Care Manager Association. Later in May 2011, 10-RRO participated as an official member in the Liaison Conference of Health Care for Disaster Victims, a newly formed all-Japan assembly of healthcare- and welfare-related organizations headed by the Japan Medical Association to facilitate inter-organizational collaboration (14).

The 10-RRO comprises 3 pillars: the strategic council, which formulates overall plans and makes decisions; the think-tank, which analyses and judges the information and situations, and recommends decision-making proposals; and the joint secretariat, which gathers and classifies information, performs daily management, and ensures coordination among the organizations and the activity bases in the affected areas. Upon commencement of activities great importance was placed on prior information collection, coordination with local representatives, and respect for the local system and manner of providing community cares, in order to provide as much useful support as possible to the affected areas, and supplement existing systems. Volunteers were recruited from among the members of each participating organization of 10-RRO, and requests for support and the availability of volunteers were matched according to the flow-chart in Fig. 1. The volunteers were expected to undergo thorough pre-dispatch orientation, using a pamphlet providing an overview of the local situation, transportation, living conditions of the dispatched staff, equipment, expected relief activities, schedule, expected behaviour and reference materials. The dispatched staff was asked to submit a daily activity report. The progress of relief activities was monitored and adjustments were made by the think-tank and the strategic council.

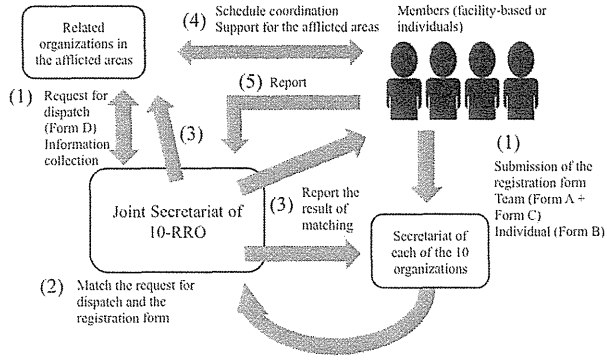

Fig. 1. Volunteer registration and dispatch: requests for dispatch (1) and registration forms of volunteers (1) are sent to the secretariat's office, where matching is performed (2). The result of matching is reported to the secretariat of each organization, to the related organizations in the afflicted areas and to the volunteers (3). Once the schedule is coordinated, support activities are initiated (4). The dispatched volunteers are requested to send daily reports to the secretariat (5). 10-PRO: 10 Rehabilitation-Related Organizations.

Description and qualitative evaluation of the support activities implemented by 10 Rehabilitation-Related Organizations

Based on the minutes of the strategic council of 10-RRO, the daily reports by the secretariat and the daily activity reports from the disaster zone, the actual relief activities implemented by 10-RRO were analysed. The survey period was from 6 May 2011, when regular dispatch of rehabilitation professionals was started, to 30 September 2011, when most of the shelters in the disaster zone were closed. The total number of dispatched rehabilitation professionals, the numbers by discipline, and the number of evacuees served were analysed.

The relief activities were also evaluated with a questionnaire directed at the executives of each organization. This comprised 10 items assessing preparedness (yes or no dichotomized rating), 10 items assessing initial relief activities (rated as very poor, poor, moderate, good, very good) of each organization, and 40 items assessing the activities of 10-RRO (rated as very poor, poor, moderate, good, very good).

RESULTS

Descriptive epidemiology of Great East Japan Earthquake and Disaster

In general, the characteristics of the GEJED were as follows (12, 13):

- it was the fourth largest earthquake in recorded history (M9, subduction zone trench-type earthquake);
- catastrophic damage was caused by a gigantic tsunami (wave height 10 m and higher, maximum run-up height 38. 9 m);
- it was geographically extensive (deaths and missing persons in 12 prefectures, and injured persons in 18 prefectures);
- overall, 15,844 persons died, 3,394 persons were still missing, 128,530 buildings and houses were completely destroyed and 240,332 were partially destroyed (as of 11 January 2012);
- there were 400,000 or more evacuees on peak days, and more than 8 million households were affected by power cuts;
- 92% of the deaths were caused by drowning due to the tsunami;
- local infrastructure and livelihood were wiped out by the tsunami;
- fisheries, agriculture, and high-technology component factories received a fatal blow;
- there was direct and indirect damage due to the destruction of the nuclear power plant;
- there was a fundamental shortage of medical and welfare facilities in the disaster areas; and
- a prolonged evacuation period of up to 6 months.

The injury to death ratio was 0.372 (5,891/15,844) (13). Among the injured, the slight injury (requiring <30 days of treatment) to serious injury (requiring ≥ 30 days of treatment) ratio was 0.01 (164 /5,527) (13). According to a survey by the Mainichi Newspaper (15), which sent a questionnaire to 35 municipalities in Miyagi, Iwate and Fukushima prefectures and received 33 responses (94.2%), 13,619 of the 1,603,409 residents (0.89%) died, while 1568 of the 76,568 residents (2.05 %) with official government certification for physical, intellectual or psychiatric disabilities died. This gives an OR of 2. 32 (95% confidence interval (CI): 2.20–2.45) of death for persons with disability.

Description and qualitative evaluation of the support activities implemented by 10 Rehabilitation-Related Organizations

Since the disaster, each organization has been actively involved in various relief activities on its own initiative, and although 10-RRO did not attempt formal coordination of these activities, mutual exchange of information was actively practiced at strategic council meetings to facilitate coordination and collaboration. Major support activities implemented by 10-RRO in 3 areas and their basic demographic information are as described below. A summary of the support activities is provided in Table I.

Support for the management of a welfare shelter in Ishinomaki city. Ishinomaki city in Miyagi Prefecture was 1 of the areas most heavily affected by this disaster. The city covers an area of 555.78 km^2, and its main industries are agriculture, fishery and marine products industries (16). Before the disaster, the population was 162,822 and the percentage of persons aged 65 years and older was 26.6%. The number of persons in need of care,

Table I. *Support activities implemented by the 10 rehabilitation-related organizations of the Great East Japan Earthquake Rehabilitation Support Service*

	Momou Agriculture Training Center in Ishinomaki	Hotel Kanyo in Kesennuma	Listel Inawashiro in Fukushima	Total
Support requested, date	27 April 2011	30 May 2011	6 June 2011	
On-the-spot investigation started, date	28 April 2011	3 June 2011	8 June 2011	
Support started, date	3 May 2011	13 June 2011	15 June 2011	
Support terminated, date	26 September 2011	30 September 2011	30 September 2011	
Total days of dispatch	146	109	107	
Evacuees, *n*				
15 June 2011	37	200	780	1,017
20 August 2011	18	138	624	780
20 September 2011	2	20	0	22
Evacuees served, cumulative, *n*	3,300	1,200	2,800	7,300
Evacuees served per day, mean, *n*	16.3	7.6	20.7	
Rehabilitation professionals dispatched, *n*[a]				
Facilities that sent professionals	12	13	8	33
Teams	21	22	19	62
Physiatrists	34	0	26	60
Nurses	100	0	0	100
Care workers	36	0	0	36
Physical therapists	184	209	153	546
Occupational therapists	184	162	114	460
Cumulative number dispatched	538	371	293	1,202
Dispatched per day mean, *n*	2.7	2.4	2.2	

[a]In terms of the tasks of different professionals, there was fair amount of overlap as we emphasized a generalist approach. In general: physiatrists were responsible for medical examination, healthcare, risk assessment and prescription of specific exercises; nurses provided assistance with medical examination, daily life support, healthcare and assessment and guidance of activities of daily living (ADL); care workers were involved in daily life support; physical therapists offered individualized exercise and fitted orthosis and equipment; and occupational therapists took responsibility for environmental improvement of the shelter, assessment and guidance of ADL, group exercise, recreational activities and assessment of temporary housing.

as defined by the Public Long-term Care Insurance Program (PLCIP) (17), was 6806 (4.2% of the population) (18). It had been an area characterized by a scarcity of medical and welfare resources, with very few rehabilitation professionals.

The damage to the city was tremendous and, according to the statistics released on 11 January 2012 (19), the number of casualties was 3,182, while 595 persons were still missing, and 22,357 buildings were completely destroyed and 11,021 partially destroyed. The peak number of evacuees was 111,295 on 15 March 2011, and they were accommodated in 179 shelters (19). Upon request from Ishinomaki city, 10-RRO commenced provision of support on 6 May 2011 by managing a newly established welfare shelter for disaster victims with disabilities and their families.

The 10-RRO teams comprised a physiatrist, a physiotherapist (PT), an occupational therapist (OT), and several nurses/care workers, and were dispatched on a weekly rotation. As shown in Table I, the cumulative number of professionals dispatched was 538, with a mean of 2.7 per day, and the cumulative number of evacuees served was 3,300, with a mean of 16.3 per day. The professionals took responsibility for adapting the environment in the shelter depending on the disability status of evacuees, provided nursing care guidance aimed at improving (or preventing deterioration of) their activities of daily living, provided group or individual rehabilitation, ensured smooth transfer to temporary housing, gave advice on its environmental improvement, and created links with the local rehabilitation and care resources. The maximum number of persons who required support was 37, together with 7 family members. The number of evacuees gradually declined as they moved to temporary housing, and support was terminated on 26 September 2011. Because local health care providers had become sufficiently functional by this time, follow-up was entrusted to them.

Rehabilitation support at a secondary shelter in Kesennuma city. Kesennuma city in Miyagi Prefecture was another area that was badly affected, especially by the tsunami and fires. The city covers an area of 333.37 km^2, and its main industries were fishery and marine products (20). Before the disaster, its population was 73,489 and the percentage of persons aged 65 years and older was 30.7%. The number of persons in need of care, as defined by PLCIP, was 3,502 (4.8% of the population) (18). Kesennuma had been an area with very limited medical and welfare resources, which deteriorated after the disaster, with very few rehabilitation professionals.

The damage to the city was enormous, and the statistics released on 11 January 2012 (19) showed that the number of casualties was 1,030, while 343 persons were still missing, 8,486 buildings were completely destroyed and 2,540 were partially destroyed. The peak number of evacuees was 20,360 on 12 March 2011, and they were accommodated in 64 shelters (19).

In response to requests by the General Leader of the Medical Aid Group and local Disaster Relief Headquarters, 10-RRO commenced provision of support from 9 June 2011. At that time, the need for acute disaster medical care had subsided, but the healthcare and long-term nursing care of those living in shelters, temporary housing or at home had become a growing concern. According to a survey conducted by the rehabilitation team of Yamagata University, there were 4,593 persons in 55 evacuation shelters as of 9 May 2011, and they estimated the percentage of victims at risk or already developing immobilization syndrome secondary due to the inactive and very restricted lifestyle in the shelters to be approximately 30% (personal communication with Dr. Michiaki Takagi of Yamagata University Hospital). Therefore, an urgent need existed for the management of persons requiring support and the prevention of new cases of immobilization syndrome.

Meanwhile, local staff on the ground actively implemented various initiatives, starting from the immediate aftermath of the earthquake. 10-RRO studied the possibility of providing complementary assistance that would be useful on the ground and lead to the establishment of a community-based rehabilitation system in the future. After thorough discussions and coordination with local representatives, 10-RRO was asked to provide assistance centred on rehabilitation support at a secondary shelter for elderly persons using Hotel Kanyo, and one PT and one OT were dispatched on 9 June 2011. Among approximately 200 evacuees accommodated at the shelter, there were 20 persons who required support and individual assistance to improve their everyday life functions. As shown in Table I, the cumulative number of professionals dispatched was 371, with a mean of 2.4 per day, and the cumulative number of evacuees served was 1,200, with a mean of 7.6 per day. The number of evacuees gradually reduced as they moved to temporary housing, and the support was terminated on 30 September 2011. Because local health care providers had become sufficiently functional by this time, follow-up was entrusted to them.

Support activities for relocated victims in Inawashiro. In Fukushima Prefecture, the GEJED not only caused damage due to the earthquake and tsunami, but radioactivity leaks occurred secondary to damage to Fukushima Nuclear Power Plant Number 1, which made the situation quite different from that in Miyagi Prefecture. As of 11 January 2012, the number of casualties in Fukushima was 1,605, while 217 persons were still missing, and 19,781 buildings and houses were completely destroyed and 61,925 partially destroyed (13). Due to radioactive contamination, many people had to leave their home towns, and as many as 61,659 persons were still living in evacuation in remote areas all over Japan (21).

After the disaster, approximately 5,000 Fukushima residents were first relocated to Saitama Super Arena in Saitama Prefecture in mid-March 2011 together with the administrative officials, and they were relocated again to 103 shelter facilities scattered around Saitama in early April 2011. Under the initiative of a 10-RRO strategic council member, rehabilitation professionals in Saitama joined forces in mid-April 2011 to promote volunteer activities at new evacuation sites. To prevent immobilization syndrome, the following activities were implemented, targeting evacuees in 103 facilities, with old Kisai

Table II. *Disaster preparedness of the 10 participating organizations (n = 10)*

Questions	Yes	No
1. Did a specific organizational disaster countermeasure system exist?	3	7
2. Were disaster countermeasures listed in the policy agenda?	1	9
3. Was a budget for disaster countermeasures individually appropriated?	0	10
4. Did a disaster countermeasure manual exist?	3	7
5. Had disaster drills and/or simulation trainings been performed?	2	8
6. Had disaster-related information been collected?	3	7
7. Had disaster-related information been utilized?	2	8
8. Were the organization's disaster countermeasures publicized to its members?	2	8
9. Did the organization collaborate with related organizations concerning disaster countermeasures?	1	9
10. Did the organization collaborate with administrative offices concerning disaster countermeasures?	1	9

High School as the main facility: (*i*) support for rehabilitation volunteers who were already active, such as the provision of individual guidance to persons requiring support/long-term nursing care; (*ii*) support for the activities of the social welfare council of Futaba town relocated to old Kisai High School, such as a day-care service; (*iii*) stretch exercises; and (*iv*) checking for immobilization syndrome risks and triage of those who need individual rehabilitation (referral to medical facilities).

Through the above support activities, Futaba town requested 10-RRO on 6 June 2011 to support evacuees accommodated at Listel Inawashiro, a condominium-type lodging used as a shelter in Fukushima. Futaba town covers an area of 51.40 km^2 facing the Pacific Ocean, and before the disaster, the population was 8,449 and the percentage of persons aged 65 years and older was 26.8% (22). This is where No. 5 and 6 nuclear power plants are located and, after the disaster, the residents were forced to leave the town. As of 6 January 2011, there were still 3,389 residents relocated to other areas in Fukushima, and 3,639 relocated to other prefectures, mostly the Tokyo Metropolitan area (23).

In the shelter, 780 Futaba residents and officials had been relocated. Due to structural barriers within the building and the psychological stress of long-term evacuation, the evacuees tended to lead inactive lives. The support activities included: working in partnership with Futaba town and related institutions; weekly dispatch of a physiatrist to provide risk management during rehabilitation support activities; and weekly rotating dispatch of PTs and OTs. In practice, individual visits were made to persons who had been identified by the public health nurses in advance. The assistance provided included improvement of their living environment and nursing care prevention support. As shown in Table I, the cumulative number of professionals dispatched was 293, a mean of 2.2 per day, and the cumulative number of evacuees served was 2,800, a mean of 20.7 per day. After most of the evacuees had moved to temporary housing, the dispatch was terminated on 30 September 2011. Because local health care providers had become sufficiently functional by this time, follow-up was entrusted to them.

Qualitative evaluation of support activities. Responses were obtained from 36 executives of the participating organizations. As for disaster preparedness, most of the 10 participating organizations were not well-prepared before the disaster (Table II). Only 3 organizations had a disaster countermeasure manual, and almost no inter-organization collaboration had been attempted. As shown in Table III, nearly half of the executives assessed the initial response as good to very good with regard to setting up a disaster management system, the timing of starting disaster countermeasures, the collection of information about the safety of the members, the collection of disaster-related information, and publicizing to the members. However, the rating regarding the planning of disaster countermeasures, relief activities in the first week, publicizing the support activities to the general public, and collaboration with other organizations and administrative offices was poor to moderate.

Table IV shows the results of evaluation of the support activities implemented by 10-RRO. The majority of respondents considered the timing of setting up 10-RRO and of starting and terminating the relief activities as appropriate. However, 25% of respondents thought that the collaborative activities should have been started earlier. The roles of the 3 pillars of 10-RRO, the strategic council, the think-tank and the joint secretariat, were judged as appropriate. Collaboration among the participating organizations, the splitting of expenses for managing the joint secretariat, the method of recruiting and matching, and the

Table III. *Initial response of the 10 participating organizations (n = 36)*

	Very poor *n* (%)	Poor *n* (%)	Moderate *n* (%)	Good *n* (%)	Very good *n* (%)	Total
1. Establishment of a disaster management system	1 (2.8)	6 (16.7)	7 (19.4)	13 (36.1)	9 (25.0)	36
2. Timing of starting disaster countermeasures	0 (0)	8 (22.2)	7 (19.4)	15 (41.7)	6 (16.7)	36
3. Collection of information about the safety of the members	0 (0)	9 (25.0)	5 (13.9)	17 (47.2)	5 (13.9)	36
4. Collection of disaster-related information	0 (0)	9 (25.0)	8 (22.2)	14 (38.9)	5 (13.9)	36
5. Planning of disaster countermeasures	1 (2.8)	10 (27.8)	9 (25.0)	8 (22.2)	8 (22.2)	36
6. Relief activities in the first week	1 (2.8)	11 (30.6)	11 (30.6)	12 (33.3)	1 (2.8)	36
7. Publicizing to the members	0 (0)	8 (22.2)	9 (25.0)	14 (38.9)	5 (13.9)	36
8. Publicizing to society	0 (0)	14 (38.9)	13 (36.1)	5 (13.9)	4 (11.1)	36
9. Collaboration with other organizations	0 (0)	4 (11.1)	18 (50.0)	9 (25.0)	5 (13.9)	36
10. Collaboration with administrative offices	0 (0)	10 (27.8)	21 (58.3)	4 (11.1)	1 (2.8)	36

Table IV. *Assessment of the support activities implemented by10 Rehabilitation-Related Organizations (10-RRO)*

	n[a]	Very bad (%)	Bad (%)	Moderate (%)	Good (%)	Very good (%)
Timing						
Of inaugurating 10-RRO	36	0.0	25.0	25.0	47.2	2.8
Of starting relief activities	36	0.0	19.4	13.9	61.1	5.6
Of terminating relief activities	36	0.0	19.4	13.9	58.3	8.3
Management						
Role of the strategic council	36	0.0	0.0	25.0	61.1	13.9
Role of the think-tank	36	0.0	0.0	19.4	55.6	25.0
Role of the joint secretariat	36	0.0	5.6	25.0	55.6	13.9
Collaboration among the organizations	36	0.0	5.6	44.4	41.7	8.3
Split of expenses for managing joint secretariat	36	0.0	11.1	38.9	44.4	5.6
Split of expenses for dispatch	36	6.0	22.2	61.1	11.1	0.0
Method of recruiting volunteers	36	0.0	0.0	44.4	52.8	2.8
Matching the volunteers and the needs	36	0.0	0.0	41.7	47.2	11.1
Selection of dispatch sites	36	0.0	0.0	25.0	52.8	22.2
Profession of dispatched volunteers[b]	100	0.0	1.0	30.0	56.0	13.0
Number of dispatched volunteers[b]	102	0.0	0.0	34.3	61.8	3.9
Support activities[b]	101	0.0	0.0	20.8	63.4	15.8
Collaboration						
With local government[b]	102	0.0	2.0	21.6	57.8	18.6
With local healthcare professionals[b]	101	0.0	0.0	29.7	63.4	7.9
With central government	34	0.0	14.7	64.7	17.6	2.9
With other organizations	34	0.0	8.8	61.8	23.5	5.9
Achievement of the aim of dispatch[b]	102	0.0	1.0	18.6	62.7	17.6
Data collection[b]	101	5.0	26.7	46.5	20.8	1.0
Publicity						
To each organization's members	36	0.0	11.1	52.8	30.6	5.6
To the society	36	0.0	50.0	41.7	8.3	0.0
To the administrative offices	36	0.0	11.1	50.0	22.2	16.7
Scientific output	36	0.0	50.0	38.9	2.8	8.3
Extraction of problems for future activities	36	0.0	13.9	50.0	33.3	2.8

[a]The total number of respondents was 36, but there were missing values for some items.

[b]These question items were asked separately for the support activities in Ishinomaki, Kesennuma and Inawashiro, but because the tendency of responses was identical, they were treated together.

selection of activity sites were also rated as appropriate, but splitting of expenses for dispatch was considered inappropriate by 28% of respondents. The support activities in the 3 areas, the professionals dispatched, actual support activities, collaboration with local government officials and healthcare professionals, and the overall achievement were judged as appropriate. However, problems regarding data collection and scientific output, and publicizing the support activities to the general public were pointed out. In the free comments, the needs for a joint rehabilitation disaster relief manual and advocating the importance of rehabilitation in disaster relief were emphasized by executives of all the participating organizations.

DISCUSSION

Descriptive epidemiology of Great East Japan Earthquake and Disaster

Most of the epidemiological data were extracted from central and local governments' official sources. In the first several months after the disaster the administrative function was disrupted in some affected areas, and accurate data collection was difficult. For this study, the data sources were accessed 10 months or more after the disaster, when the administrative function of local governments had been restored. To calculate the OR of death for persons with disability, we used data collected by one of the 3 major newspapers based on a questionnaire survey sent to local governments in the affected areas, with a high response rate. We therefore believe that the accuracy and comprehensiveness of the data used for descriptive epidemiology are satisfactory.

Compared with previous disasters, the injury to death ratio for the GEJED was remarkably low (24), as was the serious injury to slight injury ratio. No objective data are available, but it is a common understanding of almost all healthcare professionals involved in the relief activities that very few severe traumatic injuries, such as spinal cord injury, traumatic brain injury and amputation, were seen in the current disaster. Therefore, GEJED can be characterized as being a dead or alive situation with few traumatic injuries. At first we expected injuries to be frequent, based on experience of the Hanshin-Awaji Great Earthquake (10, 11), but, in fact, instead of injury management, enormous needs existed in the management of chronic illness and prevention of immobilization in elderly persons and those with pre-existing disability.

The OR of death for persons with disability compared fairly well with previous disasters (24). At the time of the tsunami, most victims with disabilities were at home, and are believed to have been unable to understand what was happening or to move to higher ground. Most of those living in specialized

facilities or joining day-care services successfully escaped from the tsunami with the assistance of staff. A more effective evacuation strategy for persons with disabilities in the community must be established.

Support activities implemented by 10 Rehabilitation-Related Organizations

This was the first attempt by various rehabilitation professionals in Japan to set up collaborative disaster relief activities. Although the importance of inter-organizational/inter-professional collaboration is well recognized and proposals to facilitate it have been made (6–8, 25), such as applying an organizational science theory to coordinating expertise among emergent groups responding to disasters (25), no detailed reports on this topic in the field of rehabilitation disaster relief are yet available, except for the recent ISPRM panel discussion (9). Our experience is therefore unique and useful in promoting future collaborative disaster relief. Based on the questionnaire evaluation of 10-RRO support activities, the appraisal was generally positive. The reasons for the initial success can be attributed to: (*i*) coordinated functioning of the 3 pillars of 10-RRO, i.e. the strategic council, think-tank and secretariat; (*ii*) selection of relief sites based on requests by local representatives, careful pre-dispatch discussion and continued coordination with them; (*iii*) pre-dispatch instruction to the professionals, emphasizing respect for local systems and manner of providing community cares and a broader generalist approach rather than a narrower specialist approach; (*iv*) formation of a team with members from the same institution or from the same district where community-based rehabilitation approaches had routinely been practiced; (*v*) dispatch duration of 1 week, with 1 day overlap with the next team to facilitate effective handing over and consistency of relief activities; (*vi*) daily communication with the dispatched professionals via internet and prompt logistic and mental support by the secretariat. These are the important lessons we have learned from the experience of 10-RRO for enabling future successful collaborative relief activities.

However, problems were highlighted regarding poor disaster preparedness, inadequate advocating and a lack of objective data collection. As for preparedness, only 3 of the 10 participating organizations had a disaster countermeasure manual prior to the GEJED. There is an urgent need to develop such a manual to improve our preparedness and enhance our capability to cope with disasters. The Rehabilitation Disaster Relief Subcommittee of the ISPRM clearly recognized the need for rehabilitation guidelines for the specific health conditions encountered during natural disasters, and it is now embarking on preparing several guidelines for rehabilitation disaster relief, focusing on conditions such as spinal cord injury, traumatic brain injury, amputees, fractures and rehabilitation needs of displaced persons with pre-existing disabilities (26). These guidelines targeting specific health conditions are important, but at the same time, based on the experience of the GEJED, we have become keenly aware of the strong need for guidelines focusing on how to implement and manage better collaborative relief activities by multiple rehabilitation-related organizations and professionals during various phases after disaster, and on how to better prepare for such activities. Therefore, 10-RRO is now working on developing a joint, multidisciplinary rehabilitation disaster relief manual with the aim of enhancing preparedness during ordinary times and acting in a coordinated manner at the time of a disaster.

The critical role of physical medicine and rehabilitation in disaster response has been emphasized recently (1–3, 5, 9). Unfortunately, however, this is seldom recognized by government officials, healthcare professionals in other fields or the general public. In the relief efforts of rehabilitation professionals after the GEJED, we often encountered this lack of recognition, and struggled to advocate its importance. However, since the establishment of 10-RRO, the situation has improved: 10-RRO is now an official member of the Liaison Conference of Health Care for Disaster Victims and the need for continued involvement of rehabilitation is listed as an item on its policy agenda; responsible officers of the Ministry of Health, Labor and Welfare have participated in the strategic council meetings as observers; good working relationships have been established with local representatives; and several news media have taken up and publicized our activities. However, there remains a serious problem, that, although physicians, dentists, nurses, pharmacists, radiological technologists, medical laboratory technicians, dental hygienists, clinical engineers, and emergency medical technicians are listed as medical professionals providing medical care at the time of a disaster in the *Disaster Relief Act* (27), PTs, OTs and speech therapists are not included. This means that the cost involved in dispatching them cannot be covered by the public sector. At first, therefore, the 10 organizations shared the expenses for managing the joint secretariat, and the member rehabilitation hospitals sending the support teams covered the dispatch expenses. In the long-term this could put an enormous financial burden on the dispatching organizations and institutions. Subsequently, based on 10-RRO activities, the government recognized the importance of rehabilitation interventions at times of disaster, and decided to subsidize the dispatch expenses by allowing a broader interpretation of the *Disaster Relief Act*. This marked an important step for future rehabilitation disaster relief.

Study limitations

Although we suggested the preliminary effectiveness of collaborative rehabilitation disaster relief implemented by 10-RRO by carrying out a questionnaire survey of executives of the participating organizations, this interim report has the following limitations. First, no detailed data for the evacuees to whom the relief services were delivered were reported. This is partly due to the overwhelming nature of the GEJED, which forced us to concentrate on building good collaborative relationships with local administrative officers and healthcare professionals who were often victims themselves, not to mention with the evacuees themselves. The dispatched professionals also worked hard to perform activities that actually brought relief to the victims, and had very limited time to collect detailed data about their disabilities and functioning using objective measures. Another reason for the lack of data collection is that ethical problems related with it under the confused disaster circumstances had not been well addressed, and the professionals had to leave

whatever data they had collected at the local government offices. To facilitate objective data collection at times of disaster, and to carry out rehabilitation disaster relief in a more scientific and evidence-based way, we are planning to contribute a guideline to the above-mentioned rehabilitation disaster relief manual.

The second limitation is that we have only conducted self-assessment of our activities, and assessments by local representatives and victims themselves have not yet been attempted. Therefore, we need to be cautious that bias in favour of 10-RRO activities is highly probable. Although we received letters of appreciation from local representatives from the 3 relief sites and positive remarks from many evacuees, we cannot provide objective data to prove the effectiveness of our collaborative activities from the clients' point of view. The reasons for this limitation are the same as those mentioned under the first limitation.

Despite these limitations, we believe that this first collaborative disaster relief endeavour by rehabilitation-related organizations and professionals has contributed to a strong foundation for future interdisciplinary and inter-organizational collaborative activities. To enhance our preparedness and response capability and to render relief activities more evidence-based, it is mandatory to develop a joint collaborative manual, a practical, efficient and ethical data collection system, and to advocate the crucial role of rehabilitation involvement in disaster response.

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Effects of olfactory stimulation on gait performance in frail older adults

Dear Editor,

Falls in elderly people are related to abnormalities in gait and balance.[1,2] In our previous work, the olfactory stimulation by essential oil during quiet standing was associated with reduced postural sway in frail older adults.[3] Because most falls occur during locomotion,[1] it is important to investigate whether olfactory stimulation can be used to improve gait function in frail older adults. Therefore, we investigated the effect of olfactory stimulation on the Timed-Up-and-Go (TUG) test[4] and 10-meter-walking (10MW) speed.[5]

A total of 14 patients (8 men and 6 women) who were admitted to an inpatient rehabilitation ward for de-conditioning were recruited. Criteria for participation included being medically and functionally stable for at least 1 week, adequately comprehending instructions, and being able to stand up and walk independently without an assistive device. The mean age, body mass index, the Barthel Index and Mini-Mental State Examination were 76.8 ± 7.2 years (mean ± SD), 23.3 ± 7.5 kg/m^2, 94.6 ± 6.6 and 23.3 ± 7.5, respectively.

Trials were carried out between 10.00 hours and 11.00 hours on separate days. The order of the two oil (lavender and grapefruit) and one sham trial exposures were randomly selected for each patients. For each stimulus, the protocol was composed of Control Phase (2 control TUG tests with a 2-min resting interval, 2-min break, 2 control 10MW with a 2-min resting interval) and Stimulation Phase (after the control phase, a 5-min break with olfactory stimulation, 2 stimulus TUG tests with a 2-min resting interval, a 2-min break with olfactory stimulation, 2 stimulus 10MW with a 2-min resting interval). For the stimuli, an investigator held a paper stick, previously dipped in one of the oils or in distilled water, within a few centimeters of, but not touching, the right side of the subject's nose. The protocol was approved by the institutional ethics committee.

In each clinical measure, data for shorter time was used. Variations among control measurements were assessed by one-way ANOVA with Tukey's post-hoc test. Comparisons between control phase and stimulation phase in each intervention were assessed with a paired Student's *t*-test.

Baseline control values of the TUG test before distilled water, lavender and grapefruit interventions were 9.9 ± 3.0 s, 10.3 ± 3.8 s and 9.6 ± 2.9 s, respectively. Baseline control values of gait speed in 10MW before distilled water, lavender and grapefruit interventions were 92.2 ± 19.1 m/min, 93.7 ± 20.0 m/min and 95.6 ± 22.8 m/min, respectively. Baseline control values of step length in 10MW before distilled water, lavender and grapefruit interventions were 0.56 ± 0.07 m, 0.55 ± 0.06 m and 0.56 ± 0.06 m, respectively. ANOVA showed no significant differences in each parameter of the control measurements with the different interventions. Figure 1 shows the fractional (%) change in each parameter. In the TUG score, the fractional decreases in lavender and grapefruit oil stimulations were significantly greater than distilled water ($P < 0.05$ and $P < 0.01$, respectively). There were no significant differences in fractional changes in walking speed and step length among distilled water, lavender or grapefruit oil stimulations.

In the current study, both lavender and grapefruit oil were associated with improvement in the TUG test, suggesting that the beneficial effect for gait performance by olfactory stimulation is not odor specific. This is consistent with previous findings that the posture stabilizing effect of olfactory stimulation is not odor specific.[3] The control of posture and motion are served by multiple sensory and motor mechanisms ranging from peripheral to cortical sensory-motor integration.[6] Odor

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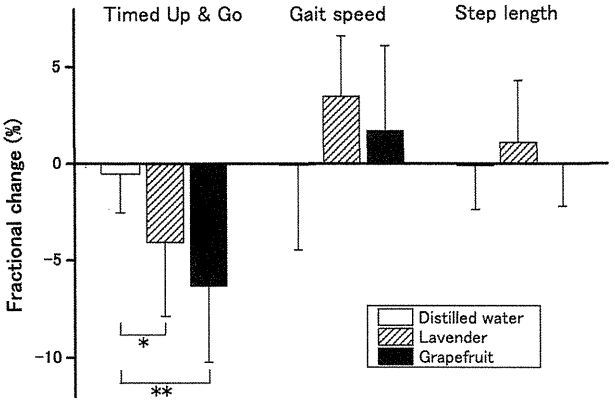

Figure 1 Fractional changes by odor stimulation on three gait performance indices. Data shown as means ± SD. Significance levels: $^{*}P < 0.05$; $^{**}P < 0.01$ versus distilled water exposure.

is one of the strongest stimuli over a wide range in the cerebral cortex. Regardless of types of odor, olfactory odor stimulation might stabilize balance by activation of the cerebral cortex.

Because TUG score is a strong predictor for fall incidence,[4,7] the present study suggests that olfactory stimulation could be a promising approach to prevent falls in older fragile adults. However, in order to apply olfactory stimulation to prevent falls in general, there are many barriers to overcome. The method using essential oil with a paper stick is not feasible to apply continuously. We have to develop a more practical method for continuous stimulation. Furthermore, the current study used acute stimulation, but chronic stimulation might have different effects. Further studies including randomized controlled trials are required to clarify the preventative role of olfactory stimulation on falls in elderly people.

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Disclosure statement

The authors have no conflicts of interest to declare.

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Coffee therapy for patients with behavioral and psychological symptoms of dementia

Dear Editor,

Behavioral and psychological symptoms of dementia (BPSD) is one of the most difficult symptoms to care for in geriatric patients.[1,2] Antipsychotics have usually been prescribed to treat BPSD. Antipsychotics have been pointed out to show side-effects, such as extrapyramidal symptoms, falls, aspiration pneumonia, spiritlessness and so on.[3,4] Non-medical care for BPSD without using antipsychotics has been proposed.[5–9] Coffee is widely distributed in the world and favored by many people. Coffee brings a calm mind, wakefulness and a pleasant feeling.[10] In the present study, coffee was used to care for BPSD.

frontiers in PHYSIOLOGY

ORIGINAL RESEARCH ARTICLE
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Impact of blunted perception of dyspnea on medical care use and expenditure, and mortality in elderly people

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Dyspnea is an alarming symptom responsible for millions of patient visits each year. Poor perception of dyspnea might be reasonably attributed to an inappropriately low level of fear and inadequate earlier medical treatment for both patients and physicians, resulting in subsequent intensive care. This study was conducted to evaluate medical care use and cost, and mortality according to the perception of dyspnea in community-dwelling elderly people. We analyzed baseline data from a community-based Comprehensive Geriatric Assessment in 2002. The perception of dyspnea in 479 Japanese community-dwelling elderly people with normal lung function was measured in August 2002. The sensation of dyspnea during breathing with a linear inspiratory resistance of 10, 20, and 30 $cmH_2O/L/s$ was rated using the Borg scale. According to the perception of dyspnea, we divided the elderly into tertiles and compared all hospitalizations, out-patient visits, costs, and death through computerized linkage with National Health Insurance beneficiaries claims history files between August 2002 and March 2008. In-patient hospitalization days and medical care costs significantly increased with the blunted perception of dyspnea, resulting in an increase in total medical-costs with blunted perception of dyspnea. With low perception group as reference, the hazard ratios of all-cause mortality were 0.65 (95% CI 0.23–1.89) for intermediate perception group and 0.31 (0.10–0.97) for high perception group, indicating the mortality rate also significantly increased with the blunted perception of dyspnea after multivariates adjustment ($p = 0.04$). The blunted perception of dyspnea is related to hospitalization, large medical costs, and all-cause mortality in community-dwelling elderly people. These findings provide a rational for preventing serious illness with careful monitoring of objective conditions in the elderly.

Keywords: dyspnea, the elderly, medical cost, medical service use, mortality

INTRODUCTION

Dyspnea is one of the most common symptoms responsible for millions of patient visits each year, and one of the most common reasons for emergency department visits and hospitalization (Fadullo et al., 1986; Parshall, 1999). Dyspnea is not only an unpleasant physical sensation which causes reductions in functional status and quality of life, but also an important alarming symptom for both patients and doctors, as it is often a harbinger of severe pathology, especially in elderly patients. The awareness that early events portend an increasing severe condition is important for timely treatment.

The etiology of dyspnea is often cardiopulmonary causes such as congestive heart failure, asthma exacerbation, chronic obstructive pulmonary diseases, pneumonia, and pulmonary embolism. However, the other causes of dyspnea, such as sepsis, anemia, acidosis, and neuromuscular diseases, must always be considered (Waseem et al., 2006). Although many of the causes of dyspnea are life-threatening, the symptom appears highly variable in comparison to levels of pathophysiology (Manning and Schwartzstein, 1995). The affective unpleasantness of perceived dyspnea has been suggested as being particularly important for motivating patients to initiate adaptive behavior, such as medication intake and physician visits, in a timely manner (Banzetto et al., 2000). In the elderly, there is a perceptual slowing for symptoms including dyspnea (Tack et al., 1982; Killian et al., 2000). Moreover, the elderly present special difficulties as several causes of dyspnea often coexist, which may further delay correct diagnosis and adequate therapy.

Since dyspnea can act as an alarm of life-threatening status, the declined perception of dyspnea may result in the delayed seeking of medical care and the severe medical conditions. However, little is known about the actual contribution of the perceptional variability of dyspnea to medical service requirements, expended medical costs, and mortality in the elderly. The objective of this study was to elucidate the impact of perception of dyspnea upon

medical care utilization and costs, and mortality in the elderly. For this purpose, we made a survey of Comprehensive Geriatric Assessment (CGA) and the perception of dyspnea in community-dwelling elderly people, and followed up their use of medical care use and cost, and all-cause mortality. Since patients with chronic respiratory diseases complain dyspnea at regular basis, the role of dyspnea as alarm might be obscured. Therefore, we focused on the elderly without chronic respiratory diseases.

We hypothesized that the assessment of the perception of dyspnea in community-dwelling elderly people would identify subjects at risk of greater medical care use and cost, and mortality.

MATERIALS AND METHODS

STUDY POPULATION

The Tsurugaya Project was a community-based Comprehensive Geriatric Assessment (CGA) conducted among elderly Japanese subjects living in Tsurugaya district, a suburban area of Sendai City in Northern Japan, between July 18th and August 8th 2002 (Kuriyama et al., 2006).

At the time of the baseline data collection, 2,780 people aged >70 years old were living in the Tsurugaya district. Letters were sent to all of these people and inviting them to participate in the health survey. Of those invited 1,178 participated in the survey, and 969 gave written informed consent for the CGA survey and medical cost follow-up to be included in the analysis. The study protocol was approved by the institutional review board of the Tohoku University Graduate School of Medicine.

QUESTIONNAIRE DATA

The CGA questionnaire includes (1) demographic characteristics (age, sex, and duration); (2) social factors (visiting friends); (3) lifestyle habits (smoking, alcohol use, and physical activity); (4) physical health (history of chronic medical condition such as stroke or myocardial infection, and present medical condition such as cancer, liver diseases, renal diseases, and angina pectoris).

Data were obtained on (1) body mass index (BMI; in kg/m^2) as calculated from anthropometric measures by a standardized protocol; (2) the presence or absence of diabetes mellitus, defined as a non-fasting blood glucose concentration >200 mg/dl or the current use of diabetic medication; (3) the presence or absence of hypertension, defined as a self-measured home systolic blood pressure >135 mmHg, a home diastolic blood pressure >85 mmHg, or the use of anti-hypertensive agents; (4) the presence or absence of hypercholesterolemia, defined as a level of 220 mg/dl or over or the current use of lipid-lowering agents; (5) the presence or absence of depressive symptoms, as assessed by using the Japanese versions of the 30-item Geriatric Depression Scale score <11 or >11 (Brink et al., 1982); (6) physical function status, assessed by using the 6-item physical function status measure of the Medical Outcomes Study (MOS) Short-form General Health Survey (Lower MOS scores indicate lower physical function status; Stewart et al., 1988); and (7) leisure-time physical activity, assessed by the frequency and duration of walking, brisk walking, and sports (Niu et al., 2005).

SPIROMETRY AND SUBJECTS SELECTION

Spirometry was performed in accordance with the American Thoracic Society recommendations (American Thoracic Society, 1995) in a sitting position with a nose clip by a laboratory technician who did not know the purpose of the study.

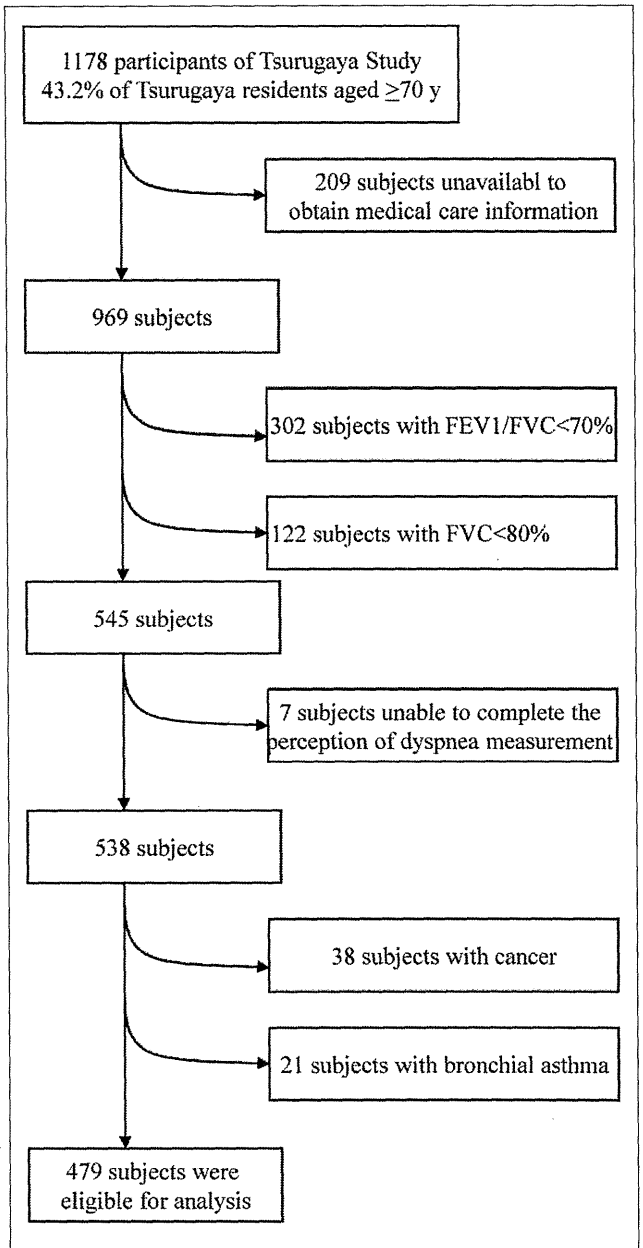

FIGURE 1 | Exclusion procedure. FEV1 denotes forced expiratory volume in 1 s, FVC forced vital capacity.

Data about the perception of dyspnea and spirometry with good maneuver were obtained from 969 of the subjects. To exclude the effect of low lung functions such as airway obstructions and pulmonary constrictions on the perception of dyspnea, 424 subjects were excluded whose forced expiratory volume in 1 s (FEV1)/forced vital capacity (FVC) ratio was <70 or whose FVC was <80% predicted. Furthermore, seven subjects were excluded who provided incomplete data of the perception of dyspnea.

Finally, 38 subjects with cancer and 21 subjects with bronchial asthma were excluded. Thus, data from 479 subjects was included in the final analyses (**Figure 1**).

PERCEPTION OF DYSPNEA

Dyspnea was induced by introducing an inspiratory resistive load to the external breathing circuit and was assessed by the modified Borg scale (Kikuchi et al., 1994; American Thoratic Society, 1999). This is well established and validated for measuring physiological as well as psychological sensations, and has been used successfully in and recommended for studies on the perception of dyspnea (American Thoratic Society, 1999; Grant et al., 1999; Lavietes et al., 2000; Livermore et al., 2008).

In brief, the sensation of dyspnea was measured while the subject breathed through the Hans–Rudolph valve with a linear inspiratory resistance (R) of 10, 20, and 30 $cmH_2O/L/s$. The loads presented with increasing magnitudes. Neither ventilation nor breathing pattern was controlled during the test. After breathing for 1 min at each level of resistance, the subject rated the sensation of dyspnea (discomfort of breathing) using a modified Borg scale. This is a category scale in which the subject selects a number, from 0 (no dyspnea) to 10 (maximal dyspnea), describing the magnitude of the sensation of dyspnea. The discomfort of breathing was not defined any further, but the subjects were instructed to avoid rating non-respiratory sensations such as headache or irritation of the pharynx.

In order to quantify the perception of dyspnea (ψ) in individuals, the following equation was used (Weiner et al., 2002):

$$\psi = \psi_{R=10} + \psi_{R=20} + \psi_{R=30} - 3 \times \psi_{R=0}$$

where $\psi_{R=0,\,10,\,20,\,30}$ represents the Borg score at $R = 0$, 10, 20, 30 $cmH_2O/L/s$, respectively. Here we tried to eliminate the mouth piece effect by subtracting the baseline sensation.

We further classified the perception of dyspnea into tertiles according to the level of ψ such as low ($0 \leq \psi < 3$, $n = 159$), intermediate ($3 \leq \psi > 9$, $n = 166$), and high ($\psi \geq 9$, $n = 175$) groups.

OUTCOME MEASUREMENTS

We collected prospective data on medical care utilization and costs, and death for each subject from August 2002 to March 2008. The health insurance system, which is compulsory for everyone living in Japan and covers almost all medical treatment and fees for medical providers, has two classifications (Tsuji et al., 1999). One is the insurance system for employes and their dependents, and the other is a system of community-based health insurance for retired persons, pensioners, the self-employed, and their dependents. The latter system is called the National Health Insurance (NHI) plan and covers almost all elderly people with very few exceptions. Therefore, we obtained allowable charges from the NHI Claim History files of the Miyagi NHI association by assessing NHI payments (reimbursement), beneficiary copayments and deductible charges by obtaining allowable charges.

Claim files included the beneficiary's ID number, personal name, the code number of the medical provider, number of visits for out-patient care, number of days for in-patient care, the death day if they died, and the charges for out-patient and in-patient care, respectively. In order to know the cause of death, we found the hospital where they were finally involved. If the hospital became bankrupt or an uncertain medical course was described in the medical chart, the cause of death was unknown.

STATISTICAL ANALYSIS

The subjects' baseline characteristics are presented according to the perception of dyspnea categorized into tertiles as the independent variables after adjustment for age and sex (**Table 2**). Differences in variables among the categories were examined by analysis of covariance for linear trends using the median values of the perception of the dyspnea in each category.

We calculated medical care costs and medical care use as per month values. Per month values for each subject were calculated by dividing the accumulated values through follow-up by the number of months observed. Except for the data shown in **Figure 3**, we examined per month values in order to avoid underestimating the medical care use and costs of the subjects who died or emigrated. The monetary values were converted into US dollars using the rate of 1 US$ = ¥115.

The impact of the perception of dyspnea upon the medical costs, and the number of out-patient visits and hospitalized days were respectively investigated, using analysis of covariance (**Table 3**). In these analyses, we regarded the following data as covariates for multivariate analysis: age category (70–74, 75–79, 80–84 years); sex; BMI (continuous variable); hypertension, hypercholesterolemia, diabetes mellitus, history of stroke, myocardial infarction, or angina pectoris, liver diseases, renal diseases (presence or absence); cognitive function (mini-Mental State Examination score of <24 or ≥24); depressive symptoms (Geriatric Depression Scale scores of <11 or ≥11); smoking (never,

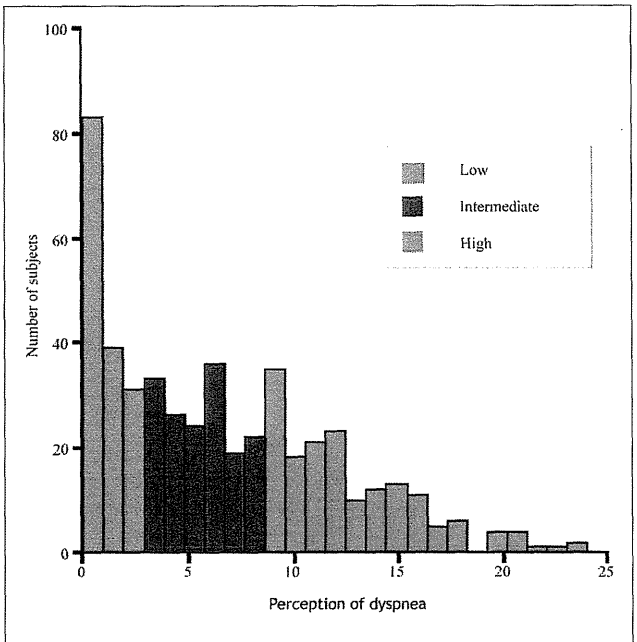

FIGURE 2 | Distributions of the perception of dyspnea.

former, and current smoker); use of alcohol (never, former, and currently drinking); use of tranquilizer (yes or no); physical functioning status (MOS scores [continuous variables]); leisure-time physical activity (Level 1: no sports, no brisk walking, no walking; Level 2: no sports, no brisk walking; low amount of walking; Level 3: no sports, no brisk walking, high amount of walking; Level 4: no sports, low amount of brisk walking, any amount of walking; Level 5: no sports, high amount of brisk walking, any amount of walking; Level 6: any amount of sports, any amounts of brisk walking, any amount of walking). Differences in variables among the categories were examined for a linear trend using the median values of the perception of the dyspnea in each category.

The survival curves according to the categories of dyspnea sensation were displayed using the Kaplan–Meier curves and also estimated by the log-rank test. We used Cox proportional hazard models to compare the all-cause mortality among the groups categorized by the perception of dyspnea in multivariate analysis, expressed by the hazard ratio. We ascertained that the proportional-hazards assumption was not violated by using log–log plots, i.e., $-\ln\{-\ln(\text{survival})\}$ curves versus ln(analysis time) of survival curves of the 3 categories by the perception of dyspnea, to check that curves were parallel.

A significant difference was defined as $p < 0.05$. All statistical analyses were performed by using the Statistical Analysis System 9.1 edition for Windows (SAS Institute Inc., Cary, NC, USA).

RESULTS

After exclusion (**Figure 1**), 479 subjects attributed to the final analysis. The distribution of the perceptions of dyspnea, which did not follow the Gaussian distribution, is shown in **Figure 2**. The subjects' baseline characteristics according to categories of the perception of dyspnea are shown in **Table 1**. No apparent associations were observed among BMI, hypertension, hypercholesterolemia, diabetes mellitus, coronary heart disease, stroke, liver and renal diseases, depressive state, drinking, and smoking status.

Among 479 subjects with normal lung function, we compared the medical care utilization and its cost according to the perceptions of dyspnea (**Table 2**). We analyzed the crude data, the data after adjustment for age, sex, and BMI, and the data adjusted for a variety of confounders. A statistically significant inverse association was observed between the perception of dyspnea and the hospitalized days per month in the crude analysis ($p = 0.02$). This association became more significant after adjustment for age, sex, and BMI, and multivariate analysis ($p = 0.01$ and $p < 0.01$, respectively). Although medical care costs for in-patient care was not

Table 1 | Baseline characteristics according to dyspnea tertile ($n = 479$).

	All	Tertile of dyspnea			*p* for trend
		Low	Intermediate	High	
No. of participants	479	153	160	166	–
Age 70–74 (%)	42.8	38.6	40.6	48.8	0.08
Age 75–79 (%)	34.7	33.3	40.0	30.7	0.63
Age 80–84 (%)	14.6	16.3	14.4	13.3	0.48
Age ≥ 85 (%)	7.9	11.8	5.0	7.2	0.15
Sex (male, %)	36.5	25.5	35.6	47.6	<0.0001
BMI (kg/m^2)	23.9 (23.6–24.2)	24.9 (24.0–25.8)	24.5 (23.7–25.3)	24.5 (23.7–25.3)	0.28
Hypertension (%)	66.0	66.7	68.8	62.7	0.62
HCL (%)	45.5	48.4	45.0	43.4	0.95
Diabetes (%)	10.4	14.4	6.3	10.8	0.46
MMSE ≥ 24 (%)	93.1	90.9	95.0	93.4	0.76
SMOKER					
Current smoker (%)	9.0	6.5	10.6	9.6	0.87
Ex-smoker (%)	25.1	19.6	24.4	30.7	0.87
Never-smoker (%)	63.3	70.6	64.4	55.4	0.67
DRINKING					
Current drinking (%)	9.2	9.2	9.4	9.0	0.46
Ex-drinking (%)	45.9	55.6	45.6	37.4	0.13
Never-drinking (%)	40.1	28.1	44.4	47.0	0.08
SELF-REPORTED ILLNESS					
Renal (%)	6.5	3.3	7.5	8.4	0.08
CHD (%)	9.8	7.2	13.8	8.4	0.42
Stroke (%)	5.0	5.2	3.8	6.0	0.90
Liver (%)	6.9	5.9	8.1	6.6	0.97

BMI, body mass index; HCL, hypercholesterolemia; MMSE, mini-Mental State Examination, CHD, coronary heart disease.
Variables are expressed as mean (95% CI) or %.

Table 2 | Adjusted medical use and costs in relation to dyspnea tertile ($n = 479$).

	Tertile of dyspnea			*p* for trend
	Low	**Intermediate**	**High**	
No. of participants	153	160	166	
IN-PATIENT CARE				
No. of hospital days (days/month)				
Crude	0.81 (0.49–1.13)	0.70 (0.39–1.02)	0.30 (−0.01–0.60)	0.02
Adjusted for age, sex, and BMI	0.61, (0.07–1.16)	0.51, (0.00–1.02)	0.03, (−0.48–0.54)*	0.01
Multivariate#	1.72, (0.54–2.91)	1.73, (0.58–2.89)	1.12, (−0.05–2.29)*†	<0.01
Medical cost (dollars/month)				
Crude	184.8, (119.3–250.3)	180.9, (116.8–245.0)	114.0, (51.1–176.9)	0.13
Adjusted for age, sex, and BMI	194.4, (82.7–306.0)	181.6, (78.6–284.7)	93.7, (−10.8–198.2)	0.03
Multivariate#	587.2, (335.9–838.6)	592.7, (347–838.4)	480.6, (232.2–728.9)*†	0.02
OUT-PATIENT CARE				
No. of hospital visits (days/month)				
Crude	5.29, (4.53–6.06)	5.2, 5(4.51–5.98)	6.00, (5.29–6.71)	0.18
Adjusted for age, sex, and BMI	5.21, (3.94–6.48)	5.21, (4.03–6.38)	5.96, (4.77–7.15)	0.16
Multivariate#	8.57, (5.75–11.39)	8.40, (5.65–11.14)	9.26, (6.48–12.04)	0.20
Medical cost (dollars/month)				
Crude	284.8, (246.0–323.5)	268.4, (230.5–306.3)	292.4, (255.2–329.6)	0.78
Adjusted for age, sex, and BMI	282.6, (215.6–349.6)	267.0, (205.2–328.8)	291.6, (228.9–354.3)	0.75
Multivariate#	472.1, (325.3–618.9)	447.8, (304.3–591.3)	468.1, (323.1–613.2)	0.88
Total medical cost (dollars/month)				
Crude	469.6, (390.2–548.9)	449.3, (371.6–526.9)	406.4, (330.2–482.6)	0.26
Adjusted for age, sex, and BMI	476.9, (341.2–612.7)	448.6, (323.3–573.9)	385.3, (258.3–512.3)	0.11
Multivariate#	1059.3, (763.8–1354.8)	1040.5, (751.7–1329.3)	948.7, (656.8–1240.7)	0.04

#Adjusted for age (70–74, 75–79, 80–84, and 85+ years), sex, body mass index, hypertension, hypercholesterolemia, diabetes, history of coronary heart disease, history of stroke, history of renal disease, history of hepatic disease, drinking status, smoking status, physical activity, physical performance, depressive symptoms, Mini-Mental State Examination, and use of tranquilizers.

Variables are presented as mean (95% CI).

p Values for trend are based on median levels in each tertile.

**p < .05 as compared with "Low" group (Tukey's post hoc).*

†p < .05 as compared with "Intermediate" group (Tukey's post hoc).

significantly different in the crude comparison, after adjustment for age, sex, and BMI, and for multivariate, there was a significant reverse association between the perception of the dyspnea and the medical care cost ($p = 0.03$ and 0.02, respectively).

In out-patient care, both the number of medical service visits and medical care costs did not significantly differ among the categories of the perception of dyspnea. These results were not changed after the adjustment for age, sex, and BMI, and the adjustment for all cofounders. Eventually, although the total medical care costs was not different in crude comparison, after adjustment for the confounders, there was a significant reverse association between the perception of the dyspnea and the total medical care cost ($p = 0.04$).

The Kaplan–Meier survival curves and their relation to the perception of dyspnea are shown in **Figure 3**. Statistics using the long-rank test did not show a significant difference among the groups ($p = 0.26$). The results of Cox regression analysis for the relationship between the perception of dyspnea and mortality are shown in **Table 3**. There was a significant reverse association between the perception of the dyspnea and hazard ratio of mortality ($p = 0.04$). The high perception of dyspnea group showed significantly lower hazard ratio than the low perception of dyspnea group. Among the 11 deaths in the low perception group, 2 died of pancreas cancer, 2 of heart failure, 1 of aortic aneurysm, 1 of ischemic heart disease, 1 of interstitial pneumonia, 1 of pneumonia and 1 of diabetes mellitus. Among the 8 deaths of intermediate perception group, 2 died of stroke, 2 of lung cancer, 1 of heart failure, 1 of burn, and 2 for unknown causes. Among the 6 deaths of high perception group, 1 died of lung cancer, 1 of pancreas cancer, 1 of respiratory failure, 1 of suffocation, and 2 for unknown causes.

DISCUSSION

This is the first community-based screening of the perception of dyspnea. Our study showed that the blunted perception of dyspnea could be related to future greater medical care use and costs, especially in the medical care cost for in-patient care. Moreover, we also showed that the blunted perception of dyspnea could be related to future greater mortality in community-dwelling elderly people. These results suggest that subjects maintaining a perception of dyspnea did not develop a more severe state of diseases and did

not require higher rates of admission to the hospital than subjects with a blunted perception of dyspnea. The awareness that early events portend an increasingly severe condition is important for timely treatment. Since dyspnea serves as an alarming symptom harboring severe pathology, patients with a well-maintained perception of dyspnea have the potential to seek care earlier before the stages which require intensive care. On the other hand, the elderly with a blunted perception of dyspnea might be high risk group for future greater medical care use presumably due to the severe diseases and risk of death.

Previous studies concerning the blunted perception of dyspnea mainly focused on asthmatics. Kikuchi et al. (1994) reported a significantly decreased perception of dyspnea against inspiratory resistive load and a decreased hypoxic ventilatory response in patients with near-fatal asthma. The impaired sensitivity to dyspnea in patients with near-fatal asthma was also confirmed by blunted dyspnea at peak exercise and breath holding (Berreiro et al., 2004; Nannini et al., 2007). Moreover, Magadle et al. (2002) prospectively confirmed that asthmatic subjects with a low perception of dyspnea are at high risk of hospitalization for near-fatal and fatal asthma. All of these findings pointed to perception as being a key factor in the overall management of asthma. However, the role of dyspnea perception has heretofore not been evaluated in the respect of the health management of elderly people.

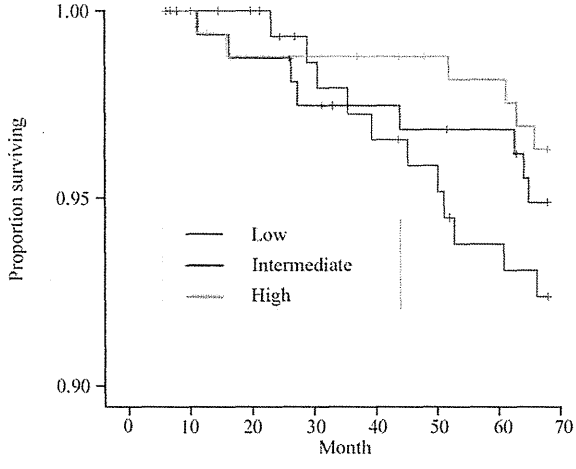

FIGURE 3 | Kaplan–Meier curves for survival of subjects according to the perception of dyspnea.

In this study, elderly women were significantly more likely ($p < 0.001$) to have a blunted dyspnea perception than were elderly men (**Table 2**). In asthmatics, several studies have shown that females report more dyspnea than males (Magadle et al., 2002; Weiner et al., 2002), and others have not (Bijl-Hofland et al., 1999; Stravinskaite et al., 2005). However, there is no report describing the gender difference in the perception of dyspnea in the non-asthmatic subjects over 70 years old. In pain perception, although the fact that females display a greater sensitivity to pain than males is well established, it was reported that the difference decreased with age and became not significant (Pickering et al., 2002). Despite many hypotheses such as biological, hormonal, genetic, that have been proposed, the cause of gender difference in pain perception still remains unclear. Cultural factors have also been adduced, with the impact of education leading to a stoic attitude and an under-reporting of pain in males (Otto and Dougher, 1985). Traditional Japanese women are educated to be patient by their mother-in-law once they get married (Yamamoto and Wallhagen, 1998). This tendency is more prominent in the north part of Japan where our study was conducted. Since our subjects were enough old to be traditional, this could be a reason why the perception of dyspnea in female scores were smaller than male in our subjects.

Like any other unpleasant alarming sensation, the impaired perception of dyspnea occurs with aging (Tack et al., 1982). In nociception, electrophysical measures have found lower nerve conduction velocity in older individuals, suggesting impairment in axon structure and function (Bouche et al., 1993). However, the cellular and molecular basis of why nociception is altered with age still remain unclear. In the elderly, there is perceptual slowing both at the peripheral and central stages of processing (Walsh et al., 1979). Further studies are required to elucidate the possible

Table 3 | Hazard ratios of all-cause mortality according to dyspnea tertile ($n = 479$).

	Tertile of dyspnea			*p* for trend
	Low $n = 153$	**Intermediate** $n = 160$	**High** $n = 166$	
Person-months of follow up	9684	10452	10963	–
No. of cases	11	8	6	–
Hazard Ratio (95% Confidence Interval)				
Crude	1.00	0.67, (0.27–1.66)	0.48, (0.18–1.29)	0.14
Adjusted for age, sex, and BMI	1.00	0.72, (0.28–1.82)	0.48, (0.17–1.31)	0.15
Multivariate[#]	1.00	0.65, (0.23–1.89)	0.31, (0.10–0.97)	0.04

[#]Adjusted for age (70–74, 75–79, 80–84, and 85+ years), sex, body mass index, hypertension, hypercholesterolemia, diabetes, history of coronary heart disease, history of stroke, history of nephropathy, history of hepatic disease, drinking status, smoking status, physical activity, physical performance, depressive symptoms, Mini Mental State Examination, and use of tranquilizers.

p Values for trend are based on median levels in each quartile.

involvement of both central and peripheral processing dysfunction in the age-related impairment of dyspnea perception.

Dyspnea in the elderly can be caused by many conditions, with cardiac and pulmonary causes being the most common (Pederden et al., 2005). The most serious limitation of this study is the unavailability of the diagnosis for each instance of medical care use. This prevents us from investigating the effects of the perception of dyspnea on a particular disease. However, it is often very difficult to clinically determine the cause of dyspnea, especially in the elderly (Cabanesb et al., 2001).

In conclusion, this is the first study to investigate the effect of the perception of the dyspnea, on medical care use and costs, and all-cause mortality in community-dwelling elderly people. Our study shows that the blunted perception of dyspnea could be related to future greater medical care costs, especially in the medical care cost for in-patient care. Moreover, it is related to higher mortality. Therefore, the screening of dyspnea perception in the elderly as part of routine medical care may be worthwhile, as blunted dyspnea perception may possibly indicate the need for more careful subsequent medical follow-up.

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