Journal of Pediatric Urology (xxxx) xxx xxx

Prune belly syndrome in Finland — A population-based study on current epidemiology and hospital admissions

Niklas Pakkasjärvi [a,b,*], Johanna Syvänen [a], Asta Tauriainen [a], Anna Hyvärinen [d], Ulla Sankilampi [c], Maarit K. Leinonen [e], Mika Gissler [e,f], Ilkka Helenius [g], Arimatias Raitio [a]

[a]Department of Pediatric Surgery, Turku University Hospital and University of Turku, Kiinamyllynkatu 4-8, 20521, Turku, Finland

[b]New Children's Hospital, Helsinki University Hospital, Stenbäckinkatu 9, 00290, Helsinki, Finland

[c]Kuopio University Hospital, Puijonlaaksontie 2, 70210, Kuopio, Finland

[d]Tampere University Hospital and Tampere University, Elämänaukio, Kuntokatu 2, 33520, Tampere, Finland

[e]Information Services Department, Finnish Institute for Health and Welfare, Mannerheimintie 166, PL 30, 00271, Helsinki, Finland

[f]Department of Molecular Medicine and Surgery, Karolinska Institute, Solnavägen 1, 17177, Solna, Sweden

[g]Department of Orthopaedics and Traumatology, University of Helsinki and Helsinki University Hospital, Topeliuksenkatu 5, 00260, Helsinki, Finland

* Correspondence to: Niklas Pakkasjärvi, Turku University Hospital, Kiinamyllynkatu 4-8, 20521, Turku, Finland Tel.: +358 2 313 0000; Fax: +358 2 313 3613
niklas.pakkasjarvi@fimnet.fi (N. Pakkasjärvi)

Keywords
Prune belly syndrome; Abdominal musculature deficiency; Urinary tract; Cryptorchidism; Epidemiology

Received 12 March 2021
Revised 15 June 2021
Accepted 21 June 2021
Available online xxx

Summary

Background
Prune belly syndrome (PBS) is a multisystem disease characterized by absent or deficient abdominal musculature with accompanying lax skin, urinary tract abnormalities, and cryptorchidism. Previous studies have estimated a birth prevalence of 1 in 35,000—50,000 live births.

Objective
We set out to clarify the epidemiology and early hospital admissions of PBS in Finland through a population-based register study. Further, possible maternal risk factors for PBS were analyzed in a case-control setting.

Study design
The Finnish Register of Congenital Malformations was linked to the Care Register for Health Care, a population-based hospital admission data for PBS patients. Additionally, five matched controls were identified in the Birth Register and maternal risk factors of PBS were studied utilizing data from the Drugs and Pregnancy database.

Results
We identified 31 cases of PBS during 1993—2015, 15 of which were live born and 16 elective terminations. The total prevalence was 1 in 44,000 births. Three patients (20%) died during infancy. On average, PBS-patients had 3.2 admissions and 10.6 hospital days per year in Finland during the study period years 1998—2015, 35- and 27-fold compared to children in Finland in general. Multiple miscarriages were significantly associated to PBS in maternal risk factor analyses.

Discussion
The burden of disease is significant in PBS, demonstrated as a high infant mortality rate (20%), multiple hospital admissions, and inpatient care in days. The available variables are limited as a register-based study.

Conclusion
We present data on contemporary epidemiology in a population-based study and show that the total prevalence of PBS is 1 in 44,000 in Finland. PBS entails a significant disease burden with admissions and hospital days over 35- and 27-fold compared to the general pediatric population, further aggravated by an infant mortality rate of 20%.

https://doi.org/10.1016/j.jpurol.2021.06.019

Please cite this article as: Pakkasjärvi N et al., Prune belly syndrome in Finland — A population-based study on current epidemiology and hospital admissions, Journal of Pediatric Urology, https://doi.org/10.1016/j.jpurol.2021.06.019

Introduction

Prune Belly Syndrome (PBS) or Eagle—Barrett syndrome is a multisystem disease characterized by an absent or deficient abdominal musculature and lax skin, urinary tract abnormalities and cryptorchidism [1]. The reported birth prevalence indicates there to be one case of PBS in every 35,000 to 50,000 live births [2]. While PBS occurs primarily in males, rare cases have been reported in females [3]. The disease spectrum is variable, ranging from infant lethality to patients with minor renal involvement. Prognosis depends primarily on the grade of urinary tract abnormalities, but multisystem involvement increases morbidity [4]. Risk factors of PBS remain mostly unknown.

We set out to clarify the epidemiology of PBS in Finland through a population-based register study using the Finnish Register of Congenital Malformations during 1993—2015. Additionally, we delineated the burden of PBS as hospital admissions and inpatient days by analyzing the Care Register for Health Care. We hypothesized that patients with PBS would present with a significantly higher health care usage than the general population. Further, to investigate risks, we performed a case-control study on maternal risk factors during pregnancy. We hypothesized that smoking, pregestational diabetes mellitus, or use of medication during the first trimester could be associated with the risk of PBS.

Material and methods

The Finnish Register of Congenital Malformations (FRM) and the Care Register for Health Care (HILMO), both maintained by the Finnish Institute for Health and Welfare (THL) were utilized for data collection [5,6]. The FRM collects data on all live births, stillbirths, and fetuses from spontaneous abortions and terminations of pregnancy for severe fetal anomalies, all with at least one major congenital anomaly. Major structural anomalies and chromosomal defects are coded according to an extended version of the 9th Revision of the International Classification of Diseases (ICD-9, ICD-10) of the World Health Organization. Minor anomalies are excluded according to the system of the European Surveillance of Congenital Anomalies, EUROCAT [7]. Nationwide linkable data on all in-patient hospital discharges (since 1967) and outpatient visits (since 1998) are registered in HILMO. Information included in the study were all live births, stillbirths, and elective terminations of pregnancy for fetal anomalies having the diagnosis code 756720 (the Atlanta modification of ICD-9) or Q79.4 (ICD-10) in the FRM in pregnancies between January 1, 1998 and December 31, 2015.

The FRM contains data on congenital and fetal anomalies from hospitals, health-care professionals and cytogenetic laboratories. The FRM also draws data with the help of the unique personal identification code (PIC) from other national health registers: the Medical Birth Register, the Register on Induced Abortions, HILMO, The Register of Visual Impairment, all maintained by THL, as well as from Cause-of-Death data, maintained by Statistics Finland. The data quality and coverage of these registers has been considered good in several studies [8—12].

The study population was cross-linked with the HILMO data by the PIC. Basic variables collected in HILMO include birth year, sex, age at visit, area of residence, hospital ID, admission and discharge days, codes for operation, operation days, as well as diagnoses of patient's medical problems. During the study period, diagnoses were recorded according to ICD-10 and operations were registered according to the Finnish version of the NOMESCO Medico-Statistical Committee (NCSP) procedure classification. All hospital admissions were analyzed between Jan 1, 1998 and Dec 31, 2015 and searched for diagnosis code Q79.4 (ICD-10) and the data of these cases was analyzed individually regarding hospital outpatient visits, inpatient care, cause of admission, length of admission, operations performed during admission and number of admissions. Two live-born females with PBS were identified from the FRM, but these were removed from the FRM and excluded from our material after re-evaluation of original patient records.

Maternal risk factors in the Medical Birth Register were analyzed with regards to BMI, parity, smoking, maternal chronical diseases, and history of miscarriages. Women with a recorded diagnosis of gestational diabetes or an abnormal oral glucose tolerance result in the Medical Birth Register were included in the gestational diabetes group. Smoking was defined as active smoking during the first trimester. Maternal weight was recorded at the first prenatal visit 8—10 weeks after conception and categorization was made based on calculated BMI. Maternal chronical diseases were acquired from the Special Reimbursement register maintained by the Social Insurance Institution of Finland (Kela). The data on maternal prescription drug purchases was available for cases and controls born after Jan 1, 1996 and it was limited to a time window of one month before conception and the first trimester of pregnancy. ATC2 groups with more than two in utero exposed cases were selected for analyses. Five healthy controls matched for maternal age ($\pm$1 year), residency, and time of conception ($\pm$1 month) were randomly selected for each case from the Medical Birth Register as previously described by Raitio [13,14].

The total prevalence of PBS was calculated as live births + stillbirths + elective terminations of pregnancy for PBS cases divided by all live births + stillbirths during the study period. The live birth prevalence was calculated as live birth PBS cases divided by all live births during the study period.

Statistical analysis

Conditional logistic regression was used for analysis of potential maternal risk factors. Odds ratios (OR) along with 95% confidence intervals (CI) were calculated. Subjects with incomplete background data were excluded from the analysis and no attempt to replace missing data was made. Analyses were performed using JMP Pro, version 15.1.0 for Windows (SAS Institute Inc., Cary, North Carolina, USA).

Ethical considerations

The approval of the Institutional Review Board at Turku University Hospital was obtained before conducting this

Please cite this article as: Pakkasjärvi N et al., Prune belly syndrome in Finland — A population-based study on current epidemiology and hospital admissions, Journal of Pediatric Urology, https://doi.org/10.1016/j.jpurol.2021.06.019

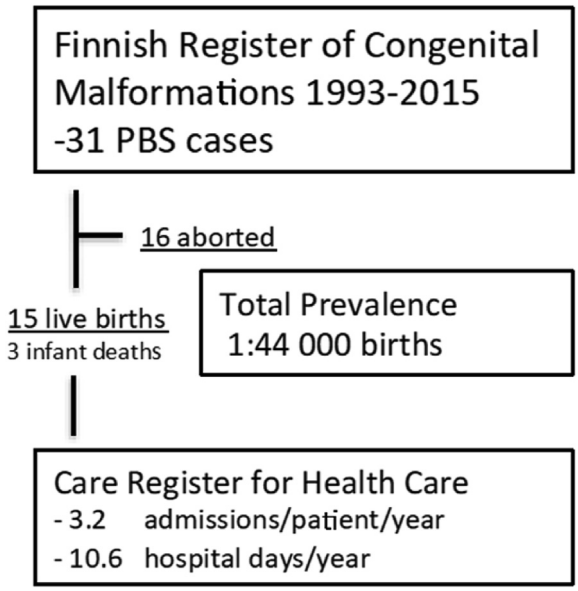

Fig. 1 Flow-chart of results.

study. Finnish Institute for Health and Welfare and Social Insurance Institution gave a permission to use their health register data in this study.

Results

We identified 31 cases of PBS in Finland between 1993 and 2015 among 1,360,628 total births. Thus, the total prevalence was 2.28 per 100,000 or one case in 44,000 births during the study period (Fig. 1).

Fifteen of the 31 PBS cases were live born, and 16 were elective terminations of pregnancy due to PBS. There were no stillbirths. The live birth prevalence for PBS in Finland was 1.11 per 100,000 or one case in 90,000 live births.

There was one twin-pregnancy, the rest were singletons. The median gestational age at birth was 37 + 1 weeks (interquartile range (IQR) 35 + 4 to 39 + 6). The median birth weight and length were 3210 g (IQR 2890 g—3560 g) and 49 cm (IQR 48 cm—50 cm), respectively. The median one-minute Apgar-score was 6 (IQR 5 to 9), eight patients needed temporary respiratory support perinatally and four patients were resuscitated. In controls, the median one-minute Apgar score was 9 (IQR 9 to 9) which was significantly higher than in Prune Belly cases ($p < 0.0001$). The mean age of the mothers at delivery was 30.9 (+/− 5.4) years which was higher than the annual mean maternal age in Finland ranging from 29.3 to 30.6 years during our study period, yet no statistically significant difference was observed, $p = 0.18$). There were three infant deaths (20%) during the study period, all occurring before the discharge after delivery; of these, two were early neonatal (<7 days of life) and one post-neonatal (2 months of age). They all presented with some or all of the following diagnoses: urinary tract obstruction, oligohydramnion, pulmonary hypoplasia, and renal failure. Infant mortality was significantly lower in controls (0%, $p = 0.006$).

Only multiple miscarriages significantly associated with PBS in the maternal risk factor analyses (Table 1). There were no mothers with pregestational diabetes among cases. No significant associations were observed with maternal prescription drug purchases and the risk of PBS (Table 2).

Hospital admissions were available for 11 live-born patients, including the three infant deaths. The birth admission was excluded from the analyses. Eight patients presented with registered abnormalities of the urinary tract. The recorded urinary tract abnormalities included vesicoureteral reflux (3 patients), obstructive uropathies of the upper tracts (hydronephrosis, hydroureteronephrosis; 6 patients) and end-stage kidney disease (4 patients). Three patients had congenital heart anomalies and three had developmental dysplasia of the hip. There were no intestinal abnormalities reported among the PBS patients, nor were there any reported procedures related to abdominal wall reconstruction during the study period.

There was a median of 48 contacts to the hospitals (IQR 16-79) and 10 admissions (IQR 2-33). The admissions yielded a median of 39 days spent in the hospital (IQR 17-110). Twenty-three percent of admissions were due to infections (of these, 70% derived from the respiratory tract and 30% from the urinary tracts). On average, these PBS-patients had 3.2 admissions and spent 10.6 days in the hospital per year. The range of follow-up was from 1 day to 17.9 years. Median follow-up time was 7.4 years (IQR 1.7—14.5). Statistically significant conclusions regarding at which age admissions are more likely could not be made.

Table 1 Univariate analysis of all analyzed maternal risk factors for Prune belly syndrome.

	Number of events		*P* value	Odds ratio	95% CI
	Cases (n = 31)	Controls (n = 145)			
Smoking	4 (26.7%)[a]	26 (18.4%)	0.44	1.61	0.47—5.45
Gestational diabetes	1 (6.7%)[a]	5 (3.5%)	0.53	2.00	0.22—18.34
Previous miscarriage (1)	5 (16.7%)	32 (22.1%)	0.70	0.81	0.28—2.32
Previous miscarriages (≥2)	4 (13.3%)	4 (2.8%)	0.01	5.42	1.28—23.07
Primiparity	12 (38.7%)	70 (48.3%)	0.33	0.68	0.31—1.50
Asthma	2 (6.5%)	3 (2.1%)	0.18	3.26	0.52—20.42

[a] Smoking and gestational diabetes data is missing in aborted cases (n = 16).

Please cite this article as: Pakkasjärvi N et al., Prune belly syndrome in Finland — A population-based study on current epidemiology and hospital admissions, Journal of Pediatric Urology, https://doi.org/10.1016/j.jpurol.2021.06.019

Table 2 Univariate analysis of all analyzed prescription drug exposures in early pregnancy in cases and controls born after Jan 1, 1996.

Drug group (ATC code)	Number of exposed child/fetus		*P* value	Odds ratio	95% CI
	Cases (n = 28)	Controls (n = 130)			
Drugs for obstructive airway diseases (R03)	2 (7.1%)	1 (0.8%)	0.08	9.92	0.87–113.5
Antibacterials for systemic use (J01)	4 (14.3%)	18 (13.9%)	0.95	1.04	0.32–3.34
Pituitary and hypothalamic hormones and analogues (H01)	2 (7.1%)	1 (0.8%)	0.08	9.92	0.87–113.5
Gynecological anti-infectives and antiseptics (G01)	2 (7.1%)	1 (0.8%)	0.08	9.92	0.87–113.5
Sex hormones and modulators of the genital system (G03)	3 (10.7%)	8 (6.2%)	0.39	1.83	0.45–7.38

Discussion

We present here data on epidemiology and burden of disease of young patients with Prune belly syndrome by linking population-health register data. The epidemiology of PBS in Finland conforms to previously reported global data with a total prevalence of approximately 1 in 44,000 births and live birth prevalence of 1 in 90,000 live births during the study period. Multiple miscarriages emerged as the only significantly associated risk factor to PBS in our analyses.

During 1993–2005, children in Finland had on average 0.09 admissions per year with on average of 0.4 days spent in hospital per year which is greatly surpassed by the admissions and days spent in hospital for the PBS patients ($p = 0.001$) [15]. Our results highlight the burden of disease measured through health care usage, which is many-fold compared to children in Finland in general [15,16].

Previously, no clear risk factors for PBS have been reported. History of recurrent miscarriages has been reported to increase the risk of omphalocele, and also of other congenital anomalies [14,17,18]. Although our results suggest that recurrent miscarriages would be a risk factor for PBS, further studies are warranted to confirm this finding. The underlying reasons for this association remain elusive. In general, genetic defects of the embryo are known to associate with a high risk of spontaneous abortion [19]. It is therefore possible, that there is a yet unknown, but common underlying defect in the embryonal development which may result in the PBS phenotype but in most cases leads to miscarriage [20].

While the etiology of PBS has been a matter of debate and undisputed evidence of involved genes is yet under investigation, a genetic component is expected. The CHRM3-gene has been implicated among familial cases, and HNF1beta-mutations have been found in 3% of cases [21–24]. It has been postulated that the abdominal wall distension would be secondary to impaired urinary bladder contraction in early pregnancy [21,25]. Mesenchymal alterations have also been suggested to occur during early development, leading to deficient abdominal wall development [4]. Clearly, more studies on the etiology and pathogenesis of PBS are needed to enable precise diagnosis and also counseling of affected families.

Currently, diagnosis relies on clinical features only. The most common mode of diagnosis is antenatal sonography, which may lead to a decision of electively terminated pregnancy for fetal anomalies in selected cases [4]. Diagnosis is usually evident perinatally by clinical findings. In more severe cases, diagnosis is undisputed, but in milder cases the diagnosis can be delayed, which may have repercussions on the urinary tract anomalies. Patients have been classified to three groups depending on the grade of renal disease [26]. We could not classify the severity of PBS in our material, but it may be that the pregnancies with most severe cases were terminated.

PBS presents as a multisystem disease with a variable spectrum ranging from mild cases to infant mortality. We deduced infant mortality to 20% in this material. However, almost half of PBS cases were electively terminated, which confounds infant mortality rates. Previously, the perinatal death rate has been estimated to as high as 29% [27]. In line with other chronic illnesses, PBS affects quality of life in patients and caregivers [28]. In a large series of 65 living patients, Grimsby et al. highlight the incidence of comorbidity, with 63% having gastrointestinal, 65% orthopedic and 49% cardiopulmonary diagnoses, respectively [29].

Limitations

Epidemiological studies with rare diseases in small populations presents with many challenges [30]. During the period spanning over 20 years analyzed in this study, changes in society are bound to happen, leading to possible variability in the case observations. Since the number of cases with PBS was small, solid conclusions concerning maternal risk factors are ambiguous. Although we only identified 31 patients, our study still presents as one of the larger cohorts attempting total ascertainment in these patients. We were unable to verify admissions in detail from the original medical records and can only rely on data

Please cite this article as: Pakkasjärvi N et al., Prune belly syndrome in Finland – A population-based study on current epidemiology and hospital admissions, Journal of Pediatric Urology, https://doi.org/10.1016/j.jpurol.2021.06.019

submitted from the hospitals to the registers. Nevertheless, the congenital malformation register has previously been proven very reliable with very high sensitivity and specificity [8,12]. Thus, our study presents reliable data on the total prevalence of PBS in Finland. From HILMO, we found evidence of urinary tract abnormalities on only 8/13 PBS patients. We only had access to admission data from 1998 onwards, possibly explaining this discrepancy. It may also be that some of the patients' urinary tract abnormalities were included in the PBS diagnosis and thus, were not listed separately in the register.

Conclusions

We present data on contemporary epidemiology in a population-based study and show that the total prevalence of PBS is 1 in 44,000 in Finland. PBS entails a significant disease burden with an infant mortality rate of 20%. The burden of disease of PBS taking into account only admissions and hospital days is 35- and 27-fold compared to the general pediatric population, respectively.

Funding

Funding was used to cover the data collection fees in the registers, but had no role in study design, the writing of the report, or the decision to submit the paper for publication.

Data sharing

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of interest

Dr Raitio, Dr Helenius and Dr Syvänen report grants from Clinical Research Institute HUCH, and Dr Raitio reports grants from the Finnish Paediatric Research Foundation.

Acknowledgements

We thank Chief Medical Officer Sonja Kiuru-Kuhlefelt from the Finnish Institute for Health and Welfare for reviewing the original patient records of two PBS females cases initially identified from the FRM.

References

[1] Eagle JF, Barrett GS. Congenital deficiency of abdominal musculature with associated genitourinary abnormalities. A syndrome: report of nine cases. Pediatrics 1950;6:726.
[2] Tonni G, Ida V, Alessandro V, Bonasoni MP. Prune-belly syndrome: case series and review of the literature regarding early prenatal diagnosis, epidemiology, genetic factors, treatment, and prognosis. Fetal Pediatr Pathol 2013;31:13—24.
[3] Reinberg Y, Shapiro E, Manivel JC, Manley CB, Pettinato G, Gonzalez R. Prune belly syndrome in females: a triad of abdominal musculature deficiency and anomalies of the urinary and genital systems. J Pediatr 1991;118:395—8.
[4] Arlen A, Nawaf C, Kirsch A. Prune belly syndrome: current perspectives. Pediatr Health Med Therapeut 2019;10:75—81.
[5] THL. Register of congenital malformations. Finnish Institute for Health and Welfare. https://thl.fi/en/web/thlfi-en/statistics/information-on-statistics/register-descriptions/register-of-congenital-malformations. [Accessed 10 November 2020].
[6] THL. Care register for health care. https://thl.fi/en/web/thlfi-en/statistics/information-on-statistics/register-descriptions/care-register-for-health-care. [Accessed 10 November 2020].
[7] EUROCAT. European surveillance of congenital anomalies. www.eurocat-network.eu. [Accessed 10 November 2020].
[8] Pakkasjärvi N, Ritvanen A, Herva R, Peltonen L, Kestilä M, Ignatius J. Lethal congenital contracture syndrome (LCCS) and other lethal arthrogryposes in Finland — and epidemiological study. Am J Med Genet A 2006;140A:1834—9.
[9] Leoncini E, Botto LD, Cocchi G, Annerén G, Bower C, Halliday J, et al. How valid are rates of down syndrome internationally? Findings from the International clearinghouse for birth defects surveillance and research. Am J Med Genet A 2010;152A:1670—80.
[10] Gissler M, Teperi J, Hemminki E, Meriläinen J. Data quality after restructuring a national medical registry. Scand J Soc Med 1995;23:75—80.
[11] Greenlees R, Neville A, Addor MC, Amar E, Arriola L, Bakker M, et al. Paper 6: EUROCAT member registries: organization and activities. Birth Defects Res Part A Clin Mol Teratol 2011;91(Suppl 1):S51—100.
[12] Syvänen J, Nietosvaara Y, Ritvanen A, Koskimies E, Kauko T, Helenius I. High risk for major nonlimb anomalies associated with lower-limb deficiency: a population-based study. J Bone Joint Surg Am 2014;96:1898—904.
[13] Raitio A, Tauriainen A, Leinonen MK, Syvänen J, Kemppainen T, Löyttyniemi E, et al. Maternal risk factors for gastroschisis: a population-based case-control study. Birth Defects Res 2020;112:989—95.
[14] Raitio A, Tauriainen A, Leinonen MK, Syvänen J, Kemppainen T, Löyttyniemi E, et al. Extended spectrum penicillins reduce the risk of omphalocele: a population-based case-control study. J Pediatr Surg 2020;S0022—3468(20):30787—9.
[15] Koskimies-Virta E, Helenius I, Pakkasjärvi N, Nietosvaara Y. Hospital care and surgical treatment of children with congenital upper limb defects. Scand J Surg 2020;109:244—9.
[16] Syvänen J, Helenius I, Koskimies-Virta E, Ritvanen A, Hurme S, Nietosvaara Y. Hospital admissions and surgical treatment of children with lower-limb deficiency in Finland. Scand J Surg 2019;108:352—60.
[17] Campana H, Rittler M, Gili JA, Poletta FA, Pawluk MS, Gimenez LG, et al. Association between a maternal history of miscarriages and birth defects. Birth Defects Res 2017;109:254—61.
[18] Yang CJ, Stone P, Stewart AW. The epidemiology of recurrent miscarriage: a descriptive study of 1214 prepregnant women with recurrent miscarriage. Aust N Z J Obstet Gynaecol 2006;46:316—22.
[19] El Hachem H, Crepaux V, May-Panloup P, Descamps P, Legendre G, Bouet P-E. Recurrent pregnancy loss: current perspectives. Int J Womens Health 2017;9:331—45.
[20] Sinico M, Touboul C, Haddad B, Encha-Razavi F, Paniel J-B, Gicquel C, et al. Giant omphalocele and "prune belly" sequence as components of the Beckwith-Wiedemann syndrome. Am J Med Genet A 2004;129A:198—200.
[21] Weber S, Thiele H, Mir S, Toliat MR, Sozeri B, Reutter H, et al. Muscarinic acetylcholine receptor M3 mutation causes urinary bladder disease and a prune-belly-like syndrome. Am J Hum Genet 2011;89:668—74.

[22] Beaman GM, Galata G, Teik KW, Urquhart JE, Aishah A, O'Sullivan J, et al. A homozygous missense variation in CHRM3 is associated with familial urinary bladder disease. Clin Genet 2019;96:515–20.
[23] Murray PJ, Thomas K, Mulgrew CG, Ellard S, Edgehill EL, Bingham C. Whole gene deletion of the hepatocyte nuclear factor-1 beta gene in a patient with the prune-belly syndrome. Nephrol Dial Transplant 2008;23:2412–5.
[24] Granberg CF, Harrison SM, Dajusta D, Zhang S, Hajarnis S, Igarashi P, et al. Genetic basis of prune belly syndrome: screening for HNF1B gene. J Urol 2012;187:272–8.
[25] Pagon RA, Smith DW, Shepard TH. Urethral obstruction malformation complex: a cause of abdominal deficiency and the 'prune belly'. J Pediatr 1979;94:900–6.
[26] Herman TE, Siegel MJ. Prune belly syndrome. J Perinatol 2009; 29:69–71.
[27] Routh JC, Huang L, Retik AB, Nelson CP. Contemporary epidemiology and characterization of newborn males with prune belly syndrome. Urology 2010;76:44–8.
[28] Arlen AM, Kirsch SS, Seidel NE, Garcia-Roig M, Smith EA, Kirsch AJ. Health-related quality of life in children with prune belly syndrome and their caregivers. Urology 2016;87:224–7.
[29] Grimsby GM, Harrison SM, Granberg CF, Bernstein I, Baker LA. Impact and frequency of extra-genitourinary manifestations of prune belly syndrome. J Pediatr Urol 2015;11:280.e1–6.
[30] Castilla EE, Mastroiacovo P. Very Rare Defects: what can we learn? Am J Med Genet C Semin Med Genet 2011;157:252–61.

Please cite this article as: Pakkasjärvi N et al., Prune belly syndrome in Finland — A population-based study on current epidemiology and hospital admissions, Journal of Pediatric Urology, https://doi.org/10.1016/j.jpurol.2021.06.019