This study aimed to evaluate the effects of wearing Lycra garments in children with cerebral palsy. Eight participants, aged 3 years 5 months to 13 years (male = 4, female = 4) and with a diagnosis of cerebral palsy, were recruited. A repeated measures design was used, with participants tested with the Gross Motor Function Measure (GMFM) and the Quality of Upper Extremity Skills Test (QUEST) before and after intervention. Both parents and participants recorded the perceived advantages and disadvantages of the participant wearing the Lycra garment at the end of the trial.

Each participant received a baseline test, was then provided with a Lycra garment and was re-tested once wear time was more than 4 hours per day. Four participants withdrew from the trial (discomfort from suit, n = 3; prescribed spinal jacket, n = 1). Of the remaining four participants, all showed an improvement in either GMFM or QUEST score and one showed improvement in both test scores. All but one of the eight participants recorded functional improvements when wearing their suit.

In this population, the participants showed improvements in function when wearing a Lycra garment, but problems with discomfort remained a barrier for some children to their more sustained use.

The Use of Lycra Garments in Children with Cerebral Palsy: a Report of a Descriptive Clinical Trial

Virginia Knox

Introduction

It has been suggested that the wearing of Lycra garments can lead to improvements in functional skills for children with cerebral palsy (Nicholson et al 2001). Therapists are increasingly required to make clinical decisions regarding whether such garments are likely to be of benefit for individual children. Currently, only a limited amount of literature exists to inform these decisions. A study of Lycra garments was therefore instituted at the Bobath Centre, which sought to extend the current evidence regarding their efficacy.

Literature review

Lycra garments have been used as dynamic splints for children with cerebral palsy (Blair et al 1995) and adults post-burns (Kennedy et al 2000) or with neurological (Gracies et al 2000) or rheumatological conditions (Murphy 1996). They are close-fitting garments, which are individually prescribed and measured. Whole-body suits, vests, ski pants, gauntlets and other variations of coverage may be prescribed. The goals of providing such a splint have included reducing hypertonus and fluctuations in tone, reducing contracture of muscle and soft tissue, and improving postural alignment, proximal stability and upper limb movements (Blair et al 1995, Gracies et al 2000, Rennie et al 2000, Nicholson et al 2001).

The close-fitting nature of the garments along with the elastic properties of the Lycra provides extra support, which may lead to increased proximal stability. The garments are constructed with the orientation of the Lycra material giving a directional pull, which can provide correction to abnormal postures and movements. Specially designed Lycra garments have been shown to apply rotational forces, which can improve supination in adults without motor impairment (Gracies et al 1997). In addition, Lycra reinforcement panels and plastic boning are sometimes used for additional support over the trunk (Blair et al 1995).

It has been suggested that within the cerebral palsy population, Lycra garments can be benefical for children with athetosis, ataxia, hypotonia or spasticity (Edmonson et al 1999, Nicholson et al 2001). Smoothing of movement and improved proximal and/or distal stability have been demonstrated in children with athetosis, ataxia and spasticity (Nicholson et al 2001). Improved trunk control, fine motor skills and sitting balance have been reported in children with hypotonia (Edmonson et al 1999). Adults with spastic hemiplegia who wore a Lycra garment on their upper limb, designed to correct the position of specific limb segments, saw improvements in wrist posture

with a reduction in hypertonus in the wrist and finger flexors (Gracies et al 2000). This suggests that similar improvements might be possible in children with hypertonus.

Lycra garments have been recognised to improve specific functions in children with cerebral palsy. Blair et al (1995) assessed 24 participants wearing Lycra garments, eight of whom had matched controls. The mean wear time was 6.5 hours per day for a mean of 53 days. The measures included video assessment and non-standardised rating scales of functional skills. Posture and upper limb movement were stated to have improved, with a reduction seen in involuntary movements.

Two studies investigated the effects of wearing a Lycra garment for more than 6 hours per day for 6 weeks, recording measurements pre-intervention and post-intervention. Nicholson et al (2001) studied 12 children with cerebral palsy. Outcome measures included the Pediatric Evaluation of Disability Inventory (PEDI) and motion analysis of a reaching task on a subgroup of five children. The group showed significant improvement across all functional skills domains of the PEDI. Four out of the five children showed improved proximal stability when reaching.

Rennie et al (2000) studied seven children with cerebral palsy and one child with muscular dystrophy using the PEDI and gait analysis. Five children showed improved scores in at least one domain of the PEDI. On gait analysis, proximal stability improved in five children. Edmonson et al (1999) studied 15 children with cerebral palsy wearing garments for 6 hours per day for 12 months, using an unspecified assessment of gross and fine motor function. Final assessment took place one month later without the garment in situ. All the children showed some functional improvements.

The above studies reported problems of compliance with wearing garments, including difficulty in donning and doffing the garment, rubbing from the garment and feeling very hot. There were also difficulties with toileting and increased frequency of urination/bowel movements or constipation.

Occupational therapists are increasingly required to make clinical decisions regarding whether Lycra garments are likely to be of benefit to children with cerebral palsy. Currently, only a limited amount of literature exists to inform these decisions. Therefore, a study of Lycra garments was instituted at the Bobath Centre, seeking to answer the following research question: does wearing a Lycra garment regularly (for more than 4 hours per day) improve gross and fine motor function in children with cerebral palsy?

Aims of study

The aims of the study were:

- To assess objectively whether functional skills improved when children were wearing a Lycra garment regularly
- To record the child's and parent's views of using Lycra garments
- For therapists to gain more experience of children wearing Lycra garments.

Method

Research design

A repeated measures design was used, with participants being tested pre-intervention and post-intervention and acting as their own controls. Children with cerebral palsy form a very heterogeneous group in both motor disorder and level of motor skills. It was not considered advantageous to attempt to obtain a matched control group because there would inevitably have been several differences between the intervention participants and the control group. Also, finance was only available for the purchase of the garments, which precluded running a larger and more in-depth study.

Sampling criteria

The inclusion criteria were as follows:

- A diagnosis of cerebral palsy
- Age 2-16 years
- No previous use of Lycra garments
- Attendance at the Bobath Centre for therapy (once a week or every fortnight)
- A child (and parent) who was interested in trying to use a Lycra garment
- Assessed as likely to benefit from the provision of a Lycra garment by his or her treating therapist.

Children were assessed as likely to benefit if they were perceived to have problems that were recognised as being amenable to treatment with a Lycra splint. Such problems were decreased proximal stability, impaired sitting balance, involuntary and/or jerky movements which were interfering with function, or abnormal rotation or other positioning of limbs which could be addressed by a specially designed Lycra garment (Edmonson et al 1999, Gracies et al 2000, Nicholson et al 2001).

Intervention protocol

The intervention consisted of wearing a Camp Lycra garment for more than 4 hours per day for 4 weeks. Previous literature has designated wear times of more than 6 hours per day, but has shown that compliance with wearing garments can be low (Rennie et al 2000). Children already wearing garments, who were known to the researcher, often wore them for only part of the day, owing to the demands of school activities such as swimming. It was decided that a minimum wear time of less than half a day might promote compliance with the regime. The usual therapeutic input continued throughout the trial and was not altered.

Garments were fitted by a Camp orthotist with the treating Bobath therapist present. These garments are constructed of Lycra, with the possibility of adding reinforcing panels or derotation bands. However, unlike Second Skin, the other main supplier, boning is not used for added stability. Consent was sought from the potential participants' parents and local community therapists.

Data collection instruments

The participants were assessed using the Gross Motor Function Measure (GMFM) (Russell et al 1989), which

assesses the gross motor abilities of children with cerebral palsy in five dimensions: (1) lie and roll, (2) sit, (3) crawl and kneel, (4) stand, and (5) walk, run and jump (Russell et al 1989, 1993). In children with cerebral palsy, the GMFM has been shown to be sensitive to change during periods of therapy (Bower and McLellan 1992, Bower et al 1996, Steinbok et al 1997).

The participants were also assessed using the Quality of Upper Extremity Skills Test (QUEST) (DeMatteo et al 1993). This assesses both function and quality of movement in the upper limbs of children with cerebral palsy, including range of motion, grasps, weight-bearing and protective extension. It was designed for children who exhibit neuromotor dysfunction with spasticity and was originally used on children with hemiplegia. Although it was expected that children with other types of cerebral palsy would be included in this trial, the test was used because, at the time of trial planning, no other appropriate upper limb assessment was available.

Data collection procedures

Assessments took place before receiving the garment and then while wearing the garment, once wear time had reached more than 4 hours per day for 4 weeks. The assessor was the author in all cases except for participant 1, for whom she was the treating therapist, so another physiotherapist performed the assessments. Both assessors had been trained in using both tests and had achieved criterion level (Kappa of more than 0.8) on the GMFM. No such testing is available for the QUEST.

At trial onset, treating Bobath therapists were asked to record their aims for each participant when wearing the garment. At the end of the trial, parents and participants (if able) completed questionnaires regarding the perceived advantages/disadvantages of the participant wearing the garment. The wearing of a Lycra garment may lead to positive improvements in function. It also inherently gives a strong sensory stimulus and could be potentially uncomfortable and time consuming to don and doff, so it was considered important to obtain the views of both the wearer and the parent. The questionnaires (see Appendix 1) contained questions regarding any difference(s) that were perceived when wearing the garment, whether the participant liked or did not like wearing the garment and some questions to the parent about the time taken for putting on/taking off the garment and actual wear time. It was recognised that the GMFM and the QUEST cover only specific aspects of function. The questionnaires were therefore also aimed at gathering subjective information regarding any other changes in function that had occurred.

At the end of the intervention, the author asked the treating therapists verbally whether they thought there were any advantages or disadvantages to the participant in wearing the garment. If these differed from those of the parent and the participant, they were recorded and presented with the parent's and the participant's comments. Information from therapists was labelled as being from the therapist. The participants were expected to continue attending the centre for therapy after the trial end. On an informal basis, the researcher recorded whether the participants continued to wear the garment after the end of the trial and whether, once the original garment had been outgrown, a further garment was requested.

Data analysis

As the data were ordinal and would not follow a normal distribution, non-parametric statistics were to be used: Wilcoxon's test to see if there was a significant difference between pre-intervention and post-intervention test scores. The probability value for statistical significance was set at 5% ($p<0.05$). Information from the parent and participant questionnaires regarding perceived advantages/disadvantages was descriptive in nature and so was not subjected to any formal analysis.

Results

A convenience sample of eight participants was recruited from children attending the Bobath Centre for therapy on a regular basis (once a week or every fortnight). Their characteristics can be seen in Table 1.

Four of the participants achieved a wearing time of more than 4 hours per day and completed the trial. Of these, at trial onset, participant 4 was already wearing a SPIO garment (Hylton and Allen 1997), which is made of thinner Lycra

Table 1. Characteristics of participants

Participant	Sex	Age	Motor disorder	GMFCS level†	Lycra garment
1	F	11y 9m	Spastic quadriplegia	4	Total body and gloves
2	F	3y 5m	Spastic diplegia	3	Total body
3	M	10y 10m	Dystonic quadriplegia	5	Total body
4	F	9y 3m	Choreoathetosis	4	Total body
5*	F	5y	Spastic diplegia	2	Shorts
6*	M	5y 7m	Dystonic quadriplegia	5	Total body
7*	M	12y 6m	Spastic quadriplegia	5	Total body
8*	M	13y	Choreoathetosis	4	Long-sleeved vest

*Never achieved 4 hours' wearing time per day.

†The Gross Motor Function Classification System (GMFCS) classifies children with cerebral palsy into five levels, according to motor ability, with particular reference to sitting and independent mobility (Palisano et al 1997).

than a Camp garment. As the family was interested in participating in the trial, it was decided to compare the SPIO garment with a Camp garment. Only the QUEST and the sitting dimension of the GMFM were tested because these were the areas expected to change.

The remaining four participants stopped wearing their garments for the following reasons: three participants (5, 7 and 8) found the garments restrictive and difficult to put on/take off and one participant (6) received a spinal jacket during the trial and was advised to wear this for 23 hours per day. Participant 5 did not have the QUEST performed because she only had Lycra shorts.

Data analysis

The small number of participants remaining in the trial meant that it was not possible to carry out any statistical analysis of data. The results of pre-intervention and post-intervention testing were inspected and compared. Information from the post-intervention questionnaires from participants and parents were collated, as well as comments from therapists. Areas where comments coincided or differed from the results of standardised testing were recorded.

The results of pre-intervention and post-intervention testing were as follows: three participants had improved GMFM total scores post-intervention and one (3) had a slightly reduced score (see Table 2).

Table 2. GMFM results

Participant	Test	Lying	Sitting	Crawling	Standing	Walking	Total
1	Pre	57	27	0	0	0	16.8
	Post	62	33	0	0	0	19.0
2	Pre	98	97	86	26	19	65.2
	Post	96	90*	93	39	19	67.4
3	Pre	71	20	0	0	0	18.2
	Post	67	13	0	0	0	16.0
4	Pre	Not tested	32	Not tested	Not tested	Not tested	32.0
	Post	Not tested	48	Not tested	Not tested	Not tested	48.0

*In error, 2 items were not tested, resulting in a potentially lower score.

Two participants (2 and 3) showed improved QUEST total scores post-intervention (see Table 3).

Table 3. QUEST results

Participant	Test	Dissociated movements	Grasps	Weight bearing	Protective extension	Total
1	Pre	7.8	-11.2	16.7	Not tested	4.4
	Post	7.8	-22.2	16.7	Not tested	0.8
2	Pre	56.3	66.7	98.0	100.0	80.3
	Post	87.5	77.8	100.0	100.0	91.3
3	Pre	1.5	7.4	33.3	0	10.6
	Post	17.2	40.7	14.3	0	18.1
4	Pre	31.3	-7.4	44.0	44.4	28.1
	Post	26.6	-7.4	30.0	33.3	20.6

Improvements thought to be due to the wearing of the Lycra garment were perceived by parents and/or participants in all but one case (participant 7). These are outlined below under individual participant results.

Individual participant results (those completing trial)

Participant 1

Participant 1 was aged 11 years 9 months, had spastic quadriplegia with a dystonic element and received a total body suit and separate gloves. The aims were to improve independent sitting time from 1 minute and to improve hand function by producing a more functional extended wrist position.

Results: GMFM scores improved. QUEST scores showed a small reduction.

Perceived benefits:

- Sitting independently for several minutes and 'felt less afraid' when sitting
- Parent found it easier to perform transfers because the participant pulled less into flexion at her shoulders and hips
- Participant drove powered chair more easily when wearing Lycra gloves because these assisted her to extend her wrist when pressing on the joystick.

Disadvantages:

- Time taken to put on suit and gloves
- More difficult computer access because the elbows were in a more extended position
- Increased difficulty in self-feeding because the wrist was still in flexion, so it was difficult to grasp and manipulate the spoon.

Participant 2

Participant 2 was aged 3 years 5 months, had spastic diplegia and received a total body suit. The aim was to improve trunk stability, so reducing the need to use the upper limbs for balance, and to improve fine manipulative skills.

Results: GMFM scores improved, especially within crawling and standing. QUEST scores improved, especially grasps and dissociated movements.

Perceived benefits: Participant enjoyed wearing the suit and said 'It keeps me warm'.

Disadvantages: Increased hip flexion when wearing suit (*Therapist*).

Participant 3

Participant 3 was aged 10 years 10 months, had spastic quadriplegia with a dystonic element and received a total body suit. The aim was to improve trunk stability and upper limb function.

Results: GMFM scores reduced (feeling unwell on day of second test). QUEST scores showed improvements in dissociated movements and grasps.

Perceived benefits:

- Able to self-feed while wearing garment
- Legs more symmetrical with less left hip adduction (*Therapist*)
- His mother commented that school helpers had reported that it was easier to help him use the bottle.

Disadvantages: Disliked having the garment put on so did not fully cooperate with the process.

Participant 4

Participant 4 was aged 9 years 3 months, had choreoathetosis and received a total body suit. The aims were to improve trunk stability and upper limb function and to compare the effects of the Camp garment with the thinner SPIO garment.

Results: Improved GMFM sitting score when wearing the Camp garment compared with the SPIO garment. The QUEST scores reduced when wearing the Camp garment because this garment was restrictive around the shoulders.

Perceived benefits: More stable in sitting

Disadvantages:

- Hot
- Difficulty with managing toileting
- The garment restricted upper limb function.

Individual participant results (those not completing trial)

Participant 5

Participant 5 was aged 5 years, had spastic diplegia and received Lycra shorts. The aim was to improve pelvic and lower trunk stability.

Wearing time: Less than 4 hours per day for less than 4 weeks.

Perceived benefits: Less knee hyperextension with improved quality of gait pattern (*Therapist*).

Disadvantages:

- Participant could not see the point of wearing the garment and did not like having the garment put on/taken off
- The garment rubbed her thighs.

Participant 6

Participant 6 was aged 5 years 7 months, had a dystonic quadriplegia and received a total body suit. The aim was to improve trunk stability and upper limb function.

Wearing time: Less than 4 hours per day. A spinal jacket was prescribed during the trial with a recommended wear time of 23 hours per day.

Perceived benefits:

- Initially had improved hand function, with less 'pulling' into flexion of arms (*Therapist and Parent*)
- Clearer speech
- Liked wearing it.

Disadvantages:

- It took 45 minutes to put the garment on
- Participant outgrew the garment very quickly, soon becoming uncomfortable.

Participant 7

Participant 7 was aged 12 years 6 months, had a spastic quadriplegia and received a total body suit. The aim was to improve trunk stability.

Wearing time: 2¼ hours per day for less than 4 weeks. The GMFM and the QUEST were not very appropriate measures because the participant had a very severe impairment.

Perceived benefits: None.

Disadvantages: The garment was uncomfortable: 'Felt too contained'.

Participant 8

Participant 8 was aged 13 years, had choreoathetosis and received a long-sleeved vest. The aim was to reduce the risk of shoulder subluxation by limiting the range of involuntary movements at the shoulders and by improving shoulder girdle stability.

Wearing time: One hour per day, including music lesson once a week, for less than 4 weeks.

Perceived benefits:

- Reduced range of involuntary movements at the shoulders
- The head of the humerus was less obvious on visual inspection and palpation, that is, it was more contained within the glenoid socket (*Therapist*)
- Easier to play drums.

Disadvantages: Participant did not like having the garment put on/taken off or wearing it because it was hot and tight.

Discussion

Because of the small number of participants remaining in the trial, it was not possible to carry out any statistical analysis of data. However, since there is limited research literature regarding the use of such garments, it was still considered important to report on the available data. Improvements in function were seen on one or both standardised tests in all four participants who completed the trial, which is in agreement with the results of other trials (Rennie et al 2000, Nicholson et al 2001). Some individual test scores did reduce post-intervention as follows: participant 3 had a slightly reduced GMFM score, but was unwell on the day of his second test, which may have affected his scores. Of the participants who had reduced QUEST scores, participant 1 had very severe upper limb involvement and could manage very few items on the QUEST. In retrospect, the QUEST was not a suitable outcome measure for that participant. Participant 4 was having trouble with the garment fitting too tightly around the shoulders, which inhibited her movement.

Functional benefits were recorded on standardised testing and by clinical observation in several participants, such as improved sitting balance, grasping of objects and self-feeding. These benefits were often outweighed by the perceived disadvantages, such as the garment being difficult and time consuming to put on/take off; hot and restrictive to wear; and, in specific cases, reducing certain functions. These findings confirm those of Rennie et al (2000) and Nicholson et al (2001). In this trial, toileting was highlighted as a problem in only one participant (4), although this has been mentioned as a common problem in all previous trials (Blair et al 1995, Edmonson et al 1999, Rennie et al 2000, Nicholson et al 2001).

Of the four participants completing the trial, all

continued wearing the garment until they outgrew it, but only one participant (4) has purchased and worn a subsequent garment. This is similar to the studies by Rennie et al (2000) and Nicholson et al (2001), where only one parent in each case was considering continuing with the child wearing the garment after the trial ceased. Edmonson et al (1999) reported that seven out of 15 children continued to wear a suit, but did not report whether subsequent suits were ordered.

The participants who continued to wear garments had the following motor disorders: participant 4 had choreoathetosis and participants 1, 2 and 3 had spastic quadriplegia, spastic diplegia and dystonic quadriplegia, but all with a degree of hypotonia in their trunk. The only child in the trial of Nicholson et al (2001) who continued to wear the garment had choreoathetosis. Six of the seven children in the trial of Edmonson et al (1999) who continued to wear garments had choreoathetosis, hypotonia or ataxia and one had spastic diplegia. The child who continued wearing the garment in the trial by Rennie et al (2000) had spastic diplegia with some hypotonia. From this limited evidence, it is suggested that the garments are most acceptable and possibly most beneficial to those children with choreoathetosis and disorders marked by hypotonia.

The children who continued wearing garments in this trial had made improvements on standardised testing and clear benefits were identified by the parent and/or child and the therapist. Children in other trials showed improvements in PEDI functional skill scores (Rennie et al 2000, Nicholson et al 2001) and balance and walking (Edmonson et al 1999). Blair et al (1995) found some weak associations with compliance in wearing the garment. These included having had a graduated increase in garment wear time; having hypertonia or involuntary movements; having a moderate to severe impairment as opposed to a mild or profound impairment; and having fewer associated problems and increased parental involvement.

Motivation on the part of the participant was recognised as important in this trial, because those participants who achieved the wear time of 4 hours and the participant who continued to wear a garment all perceived some definite functional improvements. Blair et al (1995) commented that their clinical experience suggested that older children and adults that self-initiated obtaining a garment with specific goals in mind showed good compliance.

Limitations of the study

Various factors limit the conclusions that can be drawn from this study: the small sample, lack of a control group or randomisation, the potential bias because the author was the assessor in all cases except one and the limitation in statistical analysis owing to the very small number completing the trial. In addition, the chosen standardised tests were not suitable for all the participants.

Recommendations for future study

In the future, a trial should aim to recruit a larger sample, with randomisation into control and intervention groups. Matching between individuals with cerebral palsy is very difficult because of the heterogeneity of the condition; however, groups could be stratified by age-bands and motor disorder to ensure that they were similar.

More consideration would need to be given to the choice of standardised tests in order to be applicable to the largest number of potential participants. In initial sensitivity studies of the GMFM, the most severely impaired children showed the least change over time (Russell et al 1989). These children can usually attempt only a limited number of test items, resulting in fewer degrees of freedom for change. Performance when tested with the GMFM is often affected by their health status (Bower et al 2001). However, there are currently no other more appropriate standardised outcome measures of motor function for the child exhibiting more severe cerebral palsy. The QUEST was designed for children who exhibit neuromotor dysfunction with spasticity. At the time of trial planning, it was the only available upper limb assessment of function and quality of movement for children with cerebral palsy. A more recent test, developed for all motor disorders within cerebral palsy, is the Melbourne Test of Unilateral Upper Limb Function (Randall et al 1999) and this might be more appropriate for any subsequent trials of Lycra garments.

An independent assessor, masked to group allocation, could be employed to administer the standardised tests, preceded by a pre-trial intra-rater reliability study, and so reduce potential bias. Revision of the child and parent questionnaires might allow statistical analysis of the data. A longer follow-up period would be beneficial to determine whether participants continued to wear garments and requested further garments.

Conclusion

Overall, the current evidence suggests that Lycra garments can provide functional benefits for children with cerebral palsy and, in this trial, seven out of the eight participants reported such benefits.

From the limited evidence of this study and other studies (Edmonson et al 1999, Rennie et al 2000, Nicholson et al 2001), it appears that children with choreoathetosis or some degree of hypotonia may derive the most benefits from wearing a Lycra garment. However, this must be considered within the context of the small numbers of participants involved in all these studies.

Difficulties remain with compliance in wearing Lycra garments. In this study, when the garment continued to be worn, both the child and the parent perceived functional benefits and these were noticeable from the time that the child first wore the garment. Careful assessment is required prior to the purchase of a potentially continuing expensive intervention. More research is needed regarding the long-term functional effects of such garments and improving their comfort and fit.

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Supplier

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Appendix 1. Child and parent questionnaires

Child questionnaire

1. When you wear your special suit, does it make any difference? YES/NO
   If yes,
2. What difference does it make? (to how you feel, to what you can do, etc.)
3. What do you think about wearing your suit?
   I like wearing it I don't mind wearing it I don't like to wear it

Parent questionnaire

1. Do you notice any difference when your child wears his (her) Lycra suit? YES/NO
   If yes,
2. What difference does it make?
3. What does your child usually think about wearing the suit?
   Likes wearing it Doesn't mind wearing it Doesn't like to wear it
4. How long does it take you to …?
   Put on the suit _____ Take off the suit _____
5. How many days per week on average is your child wearing the suit? _____ days
6. How many hours on average does your child wear the suit at one time? _____ hours